Final Report

**A Red Tide Monitoring Program for Texas Coastal Waters**

*Karenia brevis*

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SUMMARY

This is the final report for the red tide monitoring project conducted at The University of Texas at Austin Marine Science Institute (UTMSI) and covers the period from 1 Nov. 1998 to 10 April 2000. The study was designed to examine the seasonal dynamics of the toxic red tide dinoflagellate *Karenia brevis* (Davis) G. Hansen and Moestrup at 5 locations off the Texas coast. The work was conducted in collaboration with the Texas Parks and Wildlife Department (TPWD) utilizing bimonthly finfish surveys (Coastal Fisheries Division) to collect samples. The samples were shipped to UTMSI for chl a, nutrient, and cell count analyses.

Significant interannual variability occurred in the temperature and salinity fields. Temperature was lowest in Jan.-Feb. of each year and increased. In general, the 5 stations showed little concordance with each other. There was no annual pattern in nutrient distributions. Individual stations appeared to reflect local inputs, rather than coast wide events. The only exception was a generalized silicate increase noted in Feb-April 2001 at all stations except Brazos Santiago near Brownsville.

*Karenia brevis* was observed sporadically along the coast during the winter and most observations were limited to the summer/fall months. The sporadic occurrences and numerous "no cells" observations do not support the hypothesis that a year round resident red tide population exists in the Texas coastal zone. It appears that are transported into the area by large scale oceanographic features. The mechanism for this remains unknown.

A minor red tide occurred along South Padre Island in Oct./Nov 1999. The bloom advected south into Mexico, and no further fish kills were noted in 1999. However, *K. brevis* occurred sporadically along the coast during this time. These events suggest that *K. brevis* may be seeded into the area from further offshore regularly at very low levels. Until fish-killing populations develop, it likely remains undetected. One major red tide event occurred during 2000 that affected the entire Texas coast. A small red tide occurred along South Padre Island in July, 2000 but disappeared after moving north to Padre Island National Seashore. Fish-killing concentrations of *K. brevis* were first detected in mid August off Sabine Pass in the north and moved south along the coast over the following months. However, low level occurrences of *K. brevis* were found at intermediate stations well before the main red tide advected into the region, and were nearly coincident with the initial observations off Sabine Pass. It is impossible from this data to determine if the July bloom in south Texas was related to the events off Sabine, but there is a possibility that offshore continental shelf currents may well be transporting cells north from Mexico into northern Texas waters.

Another toxic species closely related to *K. brevis* has been seen at reasonably high abundance. This species, *Karenia mikimotoi*, is toxic to fish and has been reported to co-occur with *K. brevis* in blooms. Maximum abundance of this species was 6000 cells $L^{-1,}$ and appeared to exhibit a distinct increase and decline in population levels at 3 different stations.

BACKGROUND

The red tide dinoflagellate *K. brevi*s has been noted in the Gulf of Mexico since the earliest European explorations. The toxic dinoflagellate is icthyotoxic and can kill marine mammals that consume contaminated filter feeders. The aerosolized toxin can produce respiratory distress in sensitive humans, and consumption of contaminated shellfish can produce neurotoxic shellfish poisoning. The species is widely distributed in the open Gulf of Mexico at background concentrations of 1-100 cells $L^{-1}$; fish kills require 100-200 cells $mL^{-1}$ and shellfish beds are closed at 5 cells $mL^{-1}$. The west coast of Florida experiences regular blooms that lead to significant fish kills and human health effects (Kusek et al., 1999).

Until recently, the Texas coast has experienced few red tide events. Buskey et al. (1996) reported that the low frequency of red tide blooms in Texas might suggest that conditions favorable for initiation do not commonly occur in south Texas waters. The earliest recorded red tide event in Texas occurred in 1935 followed by a smaller less publicized event in 1955. The most severe bloom to affect Texas occurred in 1986. During this event local investigators estimated dead fish at 100,000 per linear mile over approximately 14 miles of Mustang Island beach, and these accumulations extended south into Mexico (Trebatoski, 1988). In the 1986 event, over 100 million fish may have died (L. McEachron, Red Tide Workshop, Port Aransas, TX, April 1998). Gross losses of harvested marine products from resale for the 1986 Texas red tide bloom were $3.5 million from $8.5 million (Baden 1987). The Texas coast has experienced 4 major *Karenia brevis* red tides since 1986. Successive blooms occurred in 1996, 1997, 1999, and 2000. Fish mortality from beach surveys were estimated at 3.0, 21.8, and 0.5 million for 1996, 1997, and 1999, respectively. No estimate for the number of fish killed for the 2000 red tide is available yet. The many closures of shellfish beds by Texas Department of Health (TDH) imply that *K. brevis* (or some other brevetoxin-producing phytoplankton) blooms occur with a greater frequency than is commonly realized (Buskey et al. 1996).

The induction mechanism for Texas blooms has not been resolved. Texas is similar to Florida in that blooms usually initiate offshore and prevailing winds and currents may move blooms inshore and into coastal bay systems (Buskey et al. 1996). Loop current intrusions have been suggested to lead to offshore *K. brevis* concentrations, with subsequent inshore transport. While this is a reasonable working model for the Florida west coast, the model cannot explicitly operate along the Texas coast due to the different oceanographic conditions along the Texas coast. The Loop Current does not penetrate into the western Gulf of Mexico; however, in combination with other hydrographic features it may play a crucial role in development of red tide blooms in Texas waters. Barron & Vastano (1994) proposed that *K. brevis* may be transported via gyres and eddies shed from the Loop Current, and that once in the vicinity of the Texas-Mexico shelf surface circulation patterns could integrate gyre waters into the westward coastal current. Villareal et al. (in press) noted a nutrient intrusion along the Texas continental shelf related to an anticyclonic eddy, which may be important in seeding *K. brevis* in the manner analogous to Loop Current intrusions along the coast.

A general lack of synoptic offshore sampling has precluded a rigorous evaluation of this hypothesis. An alternative hypothesis is that there is a resident or background *K. brevis* population in the near-shore Gulf of Mexico waters. Failure to find a resident, or seasonally resident, population would suggest that introduced populations are responsible for the sudden appearance of fish-killing populations.

In order to evaluate the "resident population" hypothesis, we established a multi-year sampling regime at 5 stations along the Texas coast. The sampling was coordinated with TPWD's regular finfish surveys. The National Fish and Wildlife Foundation (11-98 to 10-99) funded the initial portion of the program, while Texas Parks and Wildlife Department funded the final 19 months.

METHODS

Water samples were collected at 5 stations along the Texas coast approximately twice monthly (Fig 1). These stations are located off the Texas coast near passes in the barrier island complex and are regular sampling sites for the Coastal Fisheries Divisions (TPWD) finfish surveys. They are identified as major areas 17-21 in the TPWD database. From north to south they are: Sabine Pass (17: near the Louisiana border), Bolivar Roads Pass (18: near Galveston), Cavallo Pass (19: near Port O'Connor), Port Aransas Pass (20: near Corpus Christi), and Brazos Santiago Pass (21: near Brownsville).

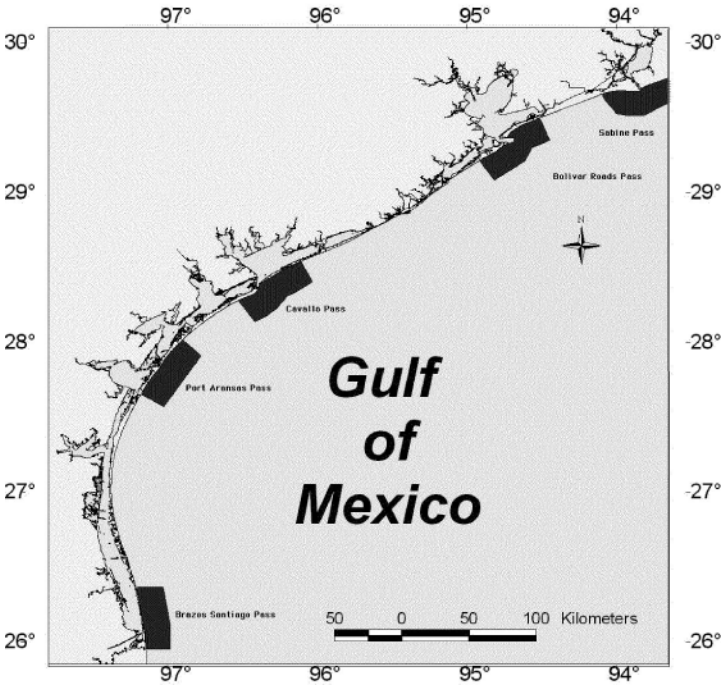



Fig. 1. Sampling sites for red tide monitoring program**.** All other figures at presented at the end of the text.

Appendix 1 illustrates the details of the individual major areas. At each site, samples were collected in random grids by TPWD as required by their sampling protocol for the finfish surveys. Samples were collected twice a month with one set coming from the first two-week

period, and the second set coming from the second two-week period. Weather and operational constraints determined the actual sampling frequency and samples could occasionally be collected within a few days of each other.

Nutrients and chlorophyll a were filtered using a 50 ml syringe equipped with a syringe head. Poretics polycarbonate filters (0.45 μm) were used for all assays. Four duplicate 10 ml samples were filtered for nutrients and frozen in the assay tubes. Quadruplicate 40 ml samples were filtered for chlorophyll *a* onto Poretics polycarbonate filters (0.45 μm) and frozen in foil pouches. One liter water samples were preserved with acid Lugol's Iodine (Throndsen, 1978) and stored in the dark. Frozen nutrient and chlorophyll samples were air expressed to UTMSI in insulated containers with ice packs. Water samples were mailed to UTMSI via U.S. mail. Temperature, salinity and oxygen data were collected by the TPWD teams and returned to UTMSI with the samples.

Nutrient analysis were conducted at The University of Texas at Austin Marine Science Institute using a LaChat QC 8000 ion analyzer with computer controlled sample selection and peak processing. Chemistries are as specified by the manufacturer and have nominal ranges as follows: nitrate+nitrate (0.03-5.0 μM; Quikchem method 31-107-04-1-A), silicate (0.03-5.0 μM; Quikchem method 31-114-27-1-B), ammonium (0.1-10 μM; Quikchem method 31-107-06-5-A) and phosphate (0.03-2.0 μM; Quikchem method 31-115-01-3-A). Nitrate+nitrite, ammonia, phosphate, and silicate were measured on triplicate samples. Effective detection level was 0.1 μM for all nutrients except silicate, which had an effective detection level of approximately 0.5 μM. These levels are somewhat higher than strictly laboratory based assays and reflect the additional handling and shipping required in this sampling. Ammonium in particular was prone to contamination. Chlorophyll *a* was measured on a Turner 10-AU fluorometer using methanol extraction and a non-acidification (Welschmeyer, 1994). This extraction method is specific for chlorophyll *a* and is not affected by the presence of chlorophyll *b* or *c*.

The high suspended particle load in Texas coastal waters, particularly in the north, created an overwhelming time commitment for counting solely by inverted microscopy. A variety of counting methods were used based on the sample characteristics. For low density samples, a 100 mL settling chamber and inverted microscopy yielded a detection limit of 10 cells $L^{-1}$. More concentrated samples required settling 1 L, decanting off the supernatant to concentrate the entire sample to 40 ml, and counting a 1 ml aliquot in a Sedgwick-Rafter cell (detection = 25 cells $L^{-1}$). This was the method used for the bulk of the samples. Under bloom conditions, only a 1 ml aliquot was counted in a Sedgwick-Rafter cell (detection – 1000 cells $L^{-1}$). For samples with high suspended particle loads and blooms a 1 ml aliquot was counted in a Sedgwick-Rafter cell. This yielded a detection limit of approximately 1000 cells per liter. .

All data was entered into a FileMaker Pro database and exported to Excel (Microsoft, Inc) for calculations. Graphics were produced in DeltaGraph Pro 4.5 (SPSS, Inc). Sample grids figures were provided by Texas Parks and Wildlife Department. The data will be submitted to the National Oceanographic Data Center within a year of final acceptance of this report.

## RESULTS

### *Hydrographic data*

Data are presented graphically in Figs. 2-6 from Sabine Pass in the north to Brazos Santiago Pass in the south and are summarized in Table 1. Temperature ($^{o}$C ) at all stations increased from the seasonal low in the winter (Jan.-Feb.) to a seasonal high in the summer (July-Aug.). There was considerable interannual variability in the seasonal extremes. For example, the

winter minimum at Sabine Pass was 13.9° C in Jan. 1999, 13.8° C in Jan. 2000, and 8.6° C in Jan. 2001. The temperature ranges in the other areas were: Bolivar Roads Pass 10.2 $^{o}$C to 30.5 $^{o}$ C, Cavallo Pass 10.8 $^{o}$C to 30.5 $^{o}$C, Port Aransas Pass 11.2 $^{o}$C to 29.9 $^{o}$C, and Brazos Santiago Pass 13.2 $^{o}$C to 30.6 $^{o}$C. The cold winter temperatures seen in Jan. 2001 at Sabine were reflected in the other stations as well. The mean annual temperatures in the 5 major areas were not substantially different. This appeared to be due to higher maxima and lower minima at the more northern stations with decreased annual amplitude in the more southern stations.

Salinity at Sabine Pass showed the greatest variability and ranged from 13.0 to 37 ppt. Salinity variations were moderate at other stations: Bolivar Roads (26.3-40), Cavallo Pass (24-38) and Port Aransas Pass (26-37). Brazos Santiago Pass, the most southerly station, showed the least variation (31-38). The temporal salinity trends at individual areas did not tract with the other areas well. Rather, it appeared each area was responding to the freshwater input from the local watershed. For example, salinity at Sabine Pass decreased from 35 to 20 ppt. during Jan 2000 to May 2000. However, Pt. Aransas Pass showed only minor variations during this time. This overall trend reflects the higher rainfall and riverine input present in northern Texas. There was no clear seasonality in the salinity data at any station. Rather, sudden decreases in salinity could occur at any time of the year. With the exception of Sabine Pass, salinity stayed well within the historical salinity tolerance of *K. brevis.* Annual means (Table 1) indicate that salinity tends to increase down the coast from Sabine to Brazos Santiago Pass by approximately 4-8 ppt, depending on the year.

Dissolved oxygen (ppm) ranged from 5-10 ppm at most stations with the exception of 2 unusually low values at Port Aransas Pass (May, 1999 and July 2000). There was no evidence of sustained low values in any area.

*Chlorophyll*

Chlorophyll measurements (Fig. 7-11) had the greatest analytical variability of the parameters measured, probably due to the lability of this compound under field sampling conditions. The highest concentrations were generally found in the north near Sabine Pass where the highest value recorded in this study (28.4 μg $L^{-1}$) was found. This station also had the greatest variability between sampling. There was no seasonal pattern found in the data; however, all stations showed a chlorophyll increase in March or April 1999. There was no consistent feature in the temperature, salinity or nutrient data that could be associated with this feature. The 4 most northern stations (Sabine, Bolivar Roads, Cavallo, and Port Aransas Pass) showed a generalized increase in chlorophyll concentration and increased oscillations during Dec. 2000-Feb. 2001. Brazos Santiago Pass had the lowest chlorophyll values overall (usually <1.00 μg chl $L^{-1}$). The onset of the 2000 red tide in Aug. was not evident in the data except at Brazos Santiago Pass. The largest chlorophyll concentration noted at this site (7.8 μg $L^{-1}$) was associated the red tide as it advected through the area on 10/13/00. A generalized increase in chlorophyll was noted off Port Aransas during Oct./Dec. 2000 that may have been related to the red tide; however, the chlorophyll pulse merges into a generalized increase and cannot be resolved independent of the pulse noted in the winter of 2000/2001. As was noted in the nutrients, mean annual chlorophyll values decrease towards the south (Table 1).

*Nutrient data*

There was no clear seasonality in the nutrient data (Fig. 12-16). As with salinity, the values could change dramatically over a very short time period. The concentration extremes for

all nutrients were greatest at the most northerly stations (Table 1). Using ammonium as an example, the ammonium maximum recorded at Sabine Pass was 3.93 mM on 5 March 2001, and ammonium values exceeded 1.0 mM 17 times during the sampling period, however, the average for all other sampling dates (n=40) was < 0.39 mM (s.e = 0.086). The highest ammonium maximum (16.84 mM) was recorded at Bolivar Roads Pass on 13 May 1999. Ammonium values exceeded 1.0 mM 23 times, and the average for all other sampling dates (n=29) was <0.5 mM (s.e=0.13). The ammonium maximum recorded at Cavallo Pass was 1.27 mM on 5 Dec. 2000, and ammonium values exceeded 1.0 mM only two times, and the average for all other sampling dates (n= 60) was <0.16 mM (s.e=0.07). Port Aransas Pass exhibited a much higher variability in ammonia concentrations that was expected based on its north-south location. The ammonium maximum recorded at Port Aransas Pass was 5.58 mM on 17 Aug. 1999, and ammonium values exceeded 1.0 mM nine times, and the average for all other sampling dates (n= 44) was <0.43 mM (s.e=0.04). The ammonium maximum recorded at Brazos Santiago Pass was 1.08 mM on 11 Oct. 1999, and ammonium values exceeded 1.0 mM only one time, and the average for all other sampling dates (n= 57) was <0.23 mM (s.e=0.07).

The mean annual ammonium concentration at Port Aransas Pass was considerably higher than Cavallo Pass to the north and Brazos Santiago Pass to the south (Table 1). The reasons for this are not clear, although it is possible that the large marsh and seagrass areas just inshore of the barrier island complex are major source of exported ammonium (P. Montoya, pers. comm.). This signal is not seen in the other nutrients.

Nitrate exhibited significant regional and temporal variations. Nitrate pulses were detected at all stations through out the sampling period except at Brazos Santiago Pass. A small regional pulse was noted in Dec.98-Jan 99, but was not evident at Brazos Santiago Pass. The maximum value of 21.0 μM was found at the Sabine Pass station in July 1999. Nitrate values at Sabine Pass decreased to <1.5 μM for the remainder of the sampling period with the exception of pulses in March, May, Nov. 2000 and a gradual increase in Feb./Mar. 2001. These pulses were sometimes, but not always associated with salinity decreases. This pattern was increasingly dampened in the southern stations with Brazos Santiago having only a few nitrate pulses that exceeded 1.5 μM with the bulk of the samples having 0.3 μM or less.

Silicate followed the same general pattern although with some significant deviations. At Sabine Pass (Fig. 12) , silicate maximum values exceed 200 μM during a period of declining salinity at the end of the study, and there were several pulses (Mar.-Jun. 99, Jun.-Jul. 00, and Jan. Mar. 01) that exceeded 50-100 μM concentration. The range and maximum values decreased in the more southerly stations. At Cavallo Pass (Fig. 14), the peak seen in Mar. 01 reached only 60-70 μM was much less than the winter peak. At Port Aransas Pass, the silicate concentration reached only 30-40 μM at this time. At Brazos Santiago Pass (Fig. 16), there was only a small maximum at this time of 20-30 μM. In contrast to the general pattern of unique local characterisstics, there was a generalized increase in Si concentration at all stations except Brazos Santiago from Feb. 2001 to March 2001. The highest Si concentrations noted during the entire study period were found at this time.

Phosphate concentrations were generally less than 0.4 μM from the period Nov. 1998 to April 2001 for most areas. The exception was at the Bolivar Roads station where values exceeded 0.3- 0.4 μM throughout much of the study period (Fig. 13). This station also had the greatest variability with values as high as 1.6 μM in replicated samples. As with other nutrients, Brazos Santiago had the lowest values and least variability in phosphate concentration.

Table 1. Summary of hydrographic, nutrient and chlorophyll data on an annual basis. The years run from Nov 1, 1998 to 31 Oct. 1999 and Nov 1, 1999 to 31 Oct. 2000. Area 17 = Sabine Pass, Area 18 = Bolivar Roads Pass, Area 19 = Cavallo Pass, Area 20 = Port Aransas Pass, Area 21 = Brazos Santiago Pass.

| Area | Year | Temperature ℃ Max/min/average/S.D. | Salinity (ppt) Max/min/average/S.D. | Chlorophyll ($\mu$g $L^{-1}$) Max/min/average/S.D. |
|---|---|---|---|---|
| 17 | 1998/1999 | 32.3/13.9/23.5/5.5 | 36.0/13.0/27.5/6.1 | 12.5/0.4/4.2/3.3 |
| 17 | 1999/2000 | 32.0/13.8/23.3/5.9 | 36.0/21.0/31.4/4.0 | 11.6/0.8/2.6/2.1 |
| 18 | 1998/1999 | 30.5/13.4/23.5/5.5 | 40.0/23.0/31.6/4.2 | 6.9/0.1/1.6/1.8 |
| 18 | 1999/2000 | 30.2/14.7/22.9/5.2 | 39.0/25.0/33.6/3.4 | 4.5/0.4/1.7/1.1 |
| 19 | 1998/1999 | 30.2/14.7/23.5/5.2 | 38.0/23.0/32.2/3.5 | 8.3/0.2/1.3/1.8 |
| 19 | 1999/2000 | 30.5/13.2/23.7/4.9 | 36.0/28.0/33.1/1.6 | 1.9/0.1/0.6/0.5 |
| 20 | 1998/1999 | 29.9/14.2/23.5/5.0 | 37.0/26.0/32.9/2.6 | 5.3/0.1/1.4/1.4 |
| 20 | 1999/2000 | 28.9/14.4/22.1/6.1 | 36.0/31.6/33.5/1.5 | 2.4/0.1/0.6/0.5 |
| 21 | 1998/1999 | 28.8/17.3/23.2/3.4 | 38.0/32.0/35.7/1.7 | 2.1/0.1/0.6/0.5 |
| 21 | 1999/2000 | 27.3/15.3/22.9/3.3 | 37.0/33.0/35.5/1.0 | 1.0/0.1/0.4/0.3 |

| Area | Year | Nitrate ($\mu$M) Max/min/average/S.D. | Phosphate ($\mu$M) Max/min/average/S.D. |
|---|---|---|---|
| 17 | 1998/1999 | 21.0/0.0/2.7/4.8 | 1.0/0.0/0.2/0.2 |
| 17 | 1999/2000 | 13.3/0.0/1.5/3.5 | 1.0/0.0/0.3/0.3 |
| 18 | 1998/1999 | 17.7/0.1/4.2/4.9 | 1.6/0.0/0.5/0.5 |
| 18 | 1999/2000 | 5.2/0.1/1.3/1.3 | 1.0/0.0/0.3/0.2 |
| 19 | 1998/1999 | 8.5/0.0/0.9/2.0 | 0.9/0.0/0.1/0.2 |
| 19 | 1999/2000 | 0.5/0.0/0.1/0.1 | 0.3/0.0/0.1/0.1 |
| 20 | 1998/1999 | 20.0/0.1/2.7/5.3 | 0.6/0.0/0.1/0.1 |
| 20 | 1999/2000 | 1.8/0.0/0.5/0.5 | 0.4/0.0/0.1/0.1 |
| 21 | 1998/1999 | 2.5/0.0/0.5/0.8 | 0.2/0.0/0.1/0.1 |
| 21 | 1999/2000 | 1.6/0.0/0.3/0.4 | 0.4/0.0/0.1/0.1 |

| Area | Year | Ammonium ($\mu$M) Max/min/average/S.D. | Silicate ($\mu$M) Max/min/average/S.D. |
|---|---|---|---|
| 17 | 1998/1999 | 2.4/0.0/0.6/0.6 | 53.0/3.4/28.4/14.9 |
| 17 | 1999/2000 | 1.8/0.0/0.8/0.5 | 95.2/3.9/25.1/23.1 |
| 18 | 1998/1999 | 16.8/0.0/2.3/3.8 | 120.8/6.8/29.8/24.2 |
| 18 | 1999/2000 | 23.8/0.1/3.1/5.8 | 29.8/1.9/11.3/7.6 |
| 19 | 1998/1999 | 1.1/0.0/0.2/0.3 | 52.9/3.1/13.0/10.7 |
| 19 | 1999/2000 | 0.4/0.0/0.1/0.1 | 38.7/0.0/9.9/8.8 |
| 20 | 1998/1999 | 5.6/0.0/1.1/1.6 | 57.0/3.1/12.7/11.6 |
| 20 | 1999/2000 | 3.1/0.0/0.5/0.6 | 17.6/0.0/8.1/4.2 |
| 21 | 1998/1999 | 1.1/0.0/0.3/0.4 | 17.3/3.5/8.6/4.1 |
| 21 | 1999/2000 | 0.8/0.0/0.2/0.2 | 25.6/1.4/8.8/6.4 |

The mean nutrient values in each area could vary by as much as a factor of 9 (nitrate at Cavallo Pass) between the two years (Table 1). For nutrients other than ammonium, there was a general pattern of decreasing mean concentrations towards the south. Ammonium had a maximum annual value for both years at Bolivar Roads Pass, with a secondary maximum at Port Aransas Pass. However, the sensitivity of average values to high, sporadic inputs suggests that

this should be treated as a general trend, not an instantaneous representation of the coast at any particular time.

*Cell counts*

An unexpected degree of morphological variation and taxonomic diversity in *Karenia* was noted. In this study, the taxon *Karenia brevis* includes both the widely recognized form of *K. brevis* as well as a morphotype noted after a cold front passed 10/06/2000. This morphotype had a more rounded epitheca than *K. brevis* and a much less lobate hypotheca. Preservation in Lugol's did not permit critical evaluation of the morphotype, so it was retained as a form of *K. brevis* (K. Steidinger, pers. comm.). *Karenia mikimotoi*, a related toxic species, was noted as well. A wide variety of *Gymnodinium* species were also seen and recorded but are not included in this report.

*Karenia brevis* was not continuously present along the Texas coast (Fig. 17-21). A single occurrence of 50 cells $L^{-1}$ was noted on 9/29/99 off Bolivar Roads Pass (Fig. 18). It was not present in any other samples until Oct. 1999. At that time, series of low level events occurred at Brazos Santiago and Sabine Pass (Fig. 17, 21). On 10/25/99, concentrations of 50 cells $L^{-1}$ were noted at Sabine Pass, and abundance increased to 2500 cells $L^{-1}$ on 11/17/99. Abundance decreased to below detectable levels until 1/17/00 when 18,600 cells $L^{-1}$ were seen. The Brazos Santiago event was first observed in our samples on 10/25/99 (10,000 cells $L^{-1}$) was also seen in the 11/8/99 and 11/18/99 samples at 1500 cells $L^{-1}$. It also was noted in the 1/31/00 sample. *K. brevis* did not re-occur until 1/31/00 (150 cells $L^{-1}$*).* *K. brevis* was not seen at Port Aransas Pass, Cavallo Pass, or Bolivar Roads pass during this Nov. to early Jan. period. However, a *K. mikimotoi* bloom (up to 30,000 cells $L^{-1}$) occurred, and a single observation of 7,200 cell $L^{-1}$ of *K. brevis* was noted on 1/25/00 at Bolivar Roads (Fig. 18). On 2/8/00, an abundance of 100 cells $L^{-1}$ was found at Port Aransas Pass.

In May, 2000, *K. brevis* appeared at Brazos Santiago Pass (5/16/00) at 150 cells $L^{-1}$. In July, a fish kill was reported at South Padre Island and moved north along the coast. *K. brevis* was noted on 7/10/00 at 1325 cells $L^{-1}$ in samples collected off the South Padre Island beach north of Pt. Isabel by TPWD. The bloom moved north to the southern end of the Padre Island National Seashore, and then disappeared. The July fish kill densities were not observed at our offshore monitoring sites on 7/5/00 or 7/18/00.

There were no further observations of *K. breve* from Feb. 2000 to July 2000 at the 4 northern stations. At this time, a major red tide event started on the Texas coast. On 7/17/00, an abundance of 75 cells $L^{-1}$ was observed off Sabine. In mid-August, numerous reports were received at TPWD of significant offshore fish-kills. The cell concentrations at the Sabine Pass site ranged from 3,000 to 373,000 cells $L^{-1}$ from 12 Aug. 2000 to 18 Sept. 2000. *K. brevis* then abruptly disappeared except for a minor observation on 20 Nov and 6 Dec. of 10-270 cells $L^{-1}$. Both TPWD aerial observations and on-site fish kill reports indicated the bloom moved down the coast during this time. This is clearly evident in the field data from the monitoring sites as an abundance peak that propagated south. The bloom was present at Bolivar Roads Pass on 9/27/00 at 5,740 cells $L^{-1}$. The situation at Cavallo Pass is somewhat more complex since *K. brevis* was continually present from 8/1/00 to 10/18/00. The abundance peak was reached on 10/2/00 (169,760 cells $L^{-1}$). At Port Aransas Pass, *K. brevis* was noted on 9/27/00 to 10/13/00 with a maximum abundance of 20,040 on 10/13/00. The bloom was noted last at Brazos Santiago Pass where 10/13/00 and 10/16/00 at a maximum abundance of 269,000 cells $L^{-1}$.

DISCUSSION

The overarching objective of this study was to determine if *K. breve* is continuously present in Texas coastal waters, and to evaluate its occurrence in relationship to the known salinity requirements in Florida. It is clear that this species is not, and that large fish killing blooms appear suddenly, often with few cells seen prior to the bloom.

*K. brevis* abundance appears to be generally unrelated to overall chlorophyll concentrations (Fig. 22). The two highest abundance values recorded differed by almost a factor of two in water column chlorophyll concentration. The mean annual chlorophyll concentrations (Table 1) for all stations were less in the 1999/2000 bloom year than in the year (1998/1999) with no fish killing bloom. The temporal variability in chlorophyll concentration, particularly in the northern stations, also supports the notion that these blooms are not a dramatic increase in total phytoplankton biomass. However, this sampling missed many of the intense near-shore events that led to significant water discoloration, so these conclusions should only be considered valid for water further offshore (approximately 1-15 km).

The temperature-salinity plot of *K. brevis* occurrence in the water column is consistent with the Florida red tide data. *K. brevis* did not occur below a salinity of approximately 29 ppt, and was most commonly noted at temperatures above 15° C although there were a few occurrences at 11°C (Fig. 23a-c). These low temperature observations occurred after the 2000 red tide and were generally the cf. *brevis* form that was first noted after a cold front in Oct. It remains unclear whether this is actually a distinct taxon or a morphotype. A frequency distribution of all the *K. brevis* observations suggests that the majority of the observations occurred between 30-35 ppt and 25-30° C (Fig. 23 b, c). There was no evidence of very low salinity occurrences as reported by Dorth et al. (1998)

The two major pulses noted (Oct-Nov. 1999 and Aug-Oct. 2000) present similarities and differences that raise questions about sources and fates of these blooms. In Oct.-Nov. 1999, the bloom was first observed in the south near Brownsville (Brazos Santiago Pass). The bloom subsequently moved south into Mexico. There was no fish killing bloom at stations north of Brazos Santiago Pass, although *K. brevis* was recorded at Sabine Pass (2,500 cells $L^{-1}$) and a significant increase of *K. mikimotoi* was noted off Galveston (Bolivar Roads Pass) at the same time. A minor *K. mikimotoi* event (ca. 500 cells $L^{-1}$) was noted off Cavallo Pass at approximately the same time. The suggestion is that a general event was occurring along the Texas coast in Oct.-Nov. of 1999 although it did not reach fish killing proportions except in the Brownsville area. The low cell abundance would have gone unnoticed at the northern 4 stations had the monitoring program not been in place.

The pattern in 2000 was similar in that a fish kill was first noted in Brownsville in July. The bloom advected north at this time and fish kills were noted as far north as the southern end of the Padre Island National Seashore. The bloom then disappeared. The major component of the bloom was noted in the Sabine area in August and advected down the coast during the Oct-Nov. time frame. Whether the two events (Brazos Santiago and Sabine Pass) are directly related may never be conclusively shown; however, satellite imagery using reflectance data (Carder et al. in prep) indicated that an extensive *Trichodesmium* bloom extended north-south off the coast. (*Trichodesmium* has been implicated as a factor pre-conditioning water for *K . brevis* blooms). Sea surface temperature data suggested that coastal water was being transported offshore and to the north, creating a quasi-upwelling. The warm water temperature in the upwelling suggested that deep, nutrient rich water was not being introduced. This was supported by the generally low nutrient levels. There are several possibilities: 1. The bloom in the two areas were discrete and

unrelated, 2). The Brownsville bloom seeded the bloom to the north after being advected east and north, or 3). A generalized offshore event was occurring that seeded both areas. These are not mutually exclusive in that 2 and 3 could have occurred at the same time.

The general southern movement of the 2000 bloom was seen in the offshore monitoring data, although the temporal linkage to coastal fish kills was not very tight (Fig. 24). Sampling 1-15 km offshore apparently missed the very nearshore transport and evolution of fish killing densities. Moreover, the surface sampling was not capable of resolving any vertical changes in cell abundance.

This monitoring program has established several characteristics of *K. brevis* along the Texas coast. There is no resident population, there are numerous low level occurrences of *K. brevis* in the coastal zone that are not linked to fish kills, and the observed temperature-salinity occurrences are consistent with the data reported from Florida. There is a possibility of considerable north-south transport along the Texas continental shelf outside the coastal zone that could result in seeding of blooms from Mexican waters into areas as far north as Sabine. Future programs should examine the role of the continental shelf circulation in latitudinal transport of seed populations, as well as the potential of mesoscale Loop Current eddies in transporting *K. brevis* into the western Gulf of Mexico.

References


Barron, C. N., & Vastano, A. C. 1994, Satellite observations of surface circulation on the Texas-Louisiana continental shelf: Journal of Geophysical Research, v. C9, p. 645-659.

Buskey, E. J., Stewart, S., Peterson, J., & Collumb, C. 1996, Current status and historical trends of brown tide and red tide phytoplankton blooms in the Corpus Christi Bay National Estuary program study area: Corpus Christi Bay National Estuary Program, CCBNEP-07, v. 85 pp.

Dortch, Q., Moncreiff, C. A., Menderhall, W. M., Parsons, M., Franks, J. S., & Hemphill, K. W. (1998). Spread of *Gymnodinium breve* into the northern Gulf of Mexico. In B. Reguera, J. Blanco, & M. L. Fernández (Eds.), Harmful Algae, (pp. 143-144). Santiago de Compostela, Spain: Xunta de Galicia and intergovernmental Oceanographi Commission of UNESCO.

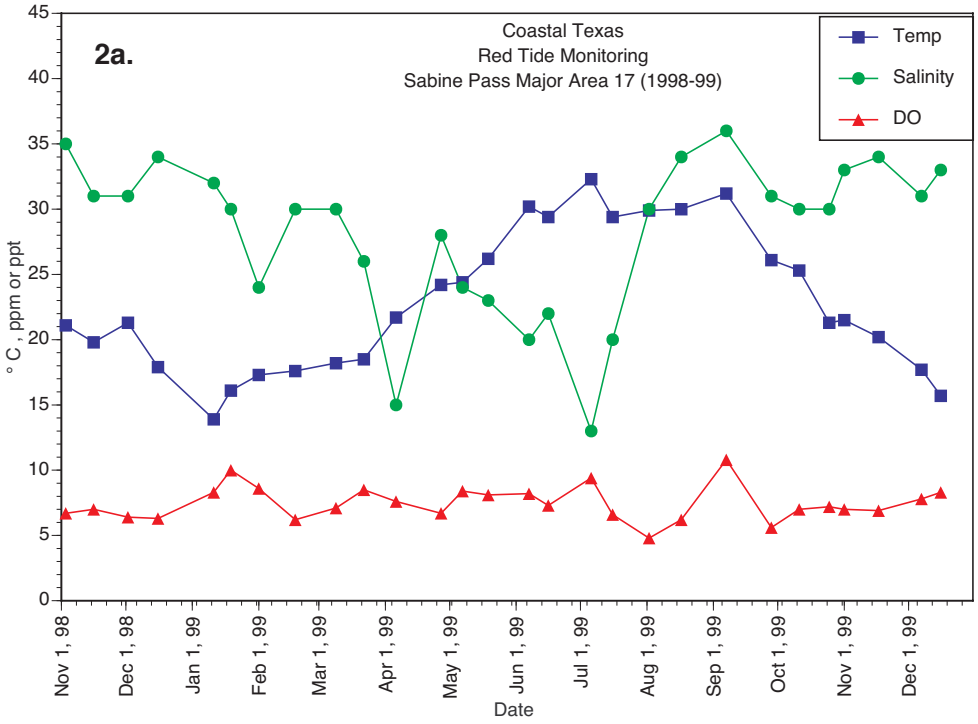
Kusek, K. M., Vargo, G., & Steidinger, K. 1999, *Gymnodinium breve* in the field, in the lab, and in the newspaper - a scientific and journalistic analysis of Florida red tides: Contributions in Marine Science, v. 34, p. 1-229.

Throndsen, J. (1978). Preservation and storage. In A. Sournia (Ed.), Phytoplankton Manual, (pp. 69-74). Norwich: United Nations Educational, Scientific and Cultural Organization, Page Brothers, Ltd.

Trebatoski, B. 1988, Observations on the 1986-87 Texas red tide (*Ptychodiscus brevis*): Texas Water Commission Rep. 88-02, v.

Villareal, T. A., Brainard, M. A., & McEachron, L. W. (in press). *Gymnodinium breve* (Dinophyceae) in the western Gulf of Mexico: resident versus advected populations as a seed stock for blooms. 9th Int. Conf. on Harmful Algal Blooms., Hobart, Tasmania.

Figure 2. Hydrographic data (temperature, salinity and dissolved oxygen) for Sabine Pass. Fig. 2a. 1998-1999. Fig. 2b. 2000-2001.



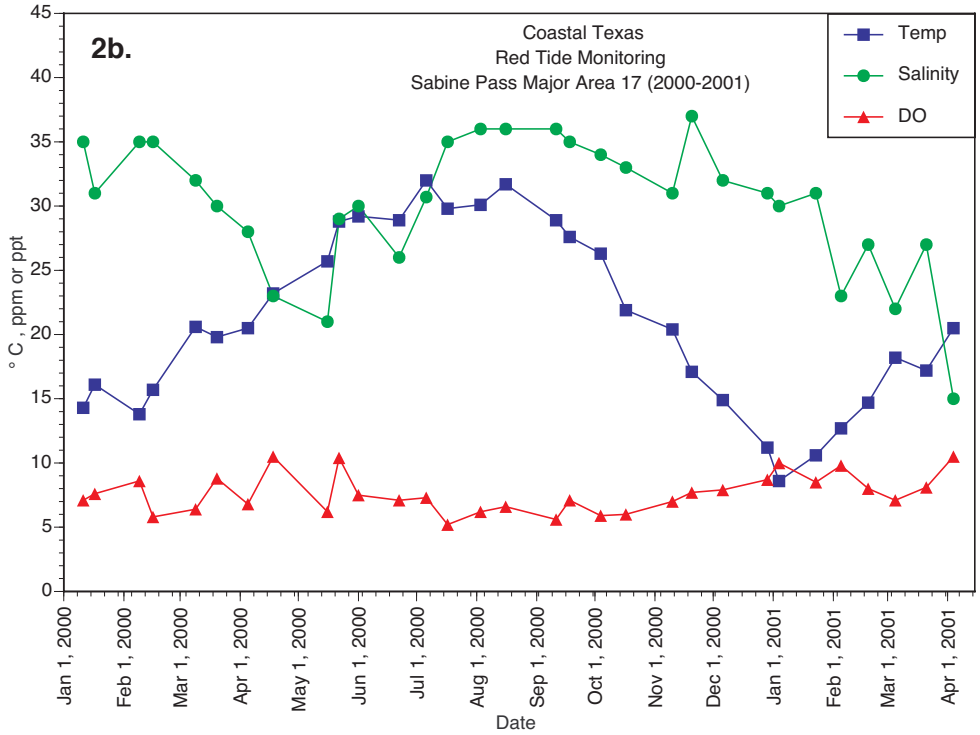



Figure 3. Hydrographic data (temperature, salinity and dissolved oxygen) for Bolivar Roads Pass.. Fig. 3a. 1998-1999. Fig. 3b. 2000-2001.

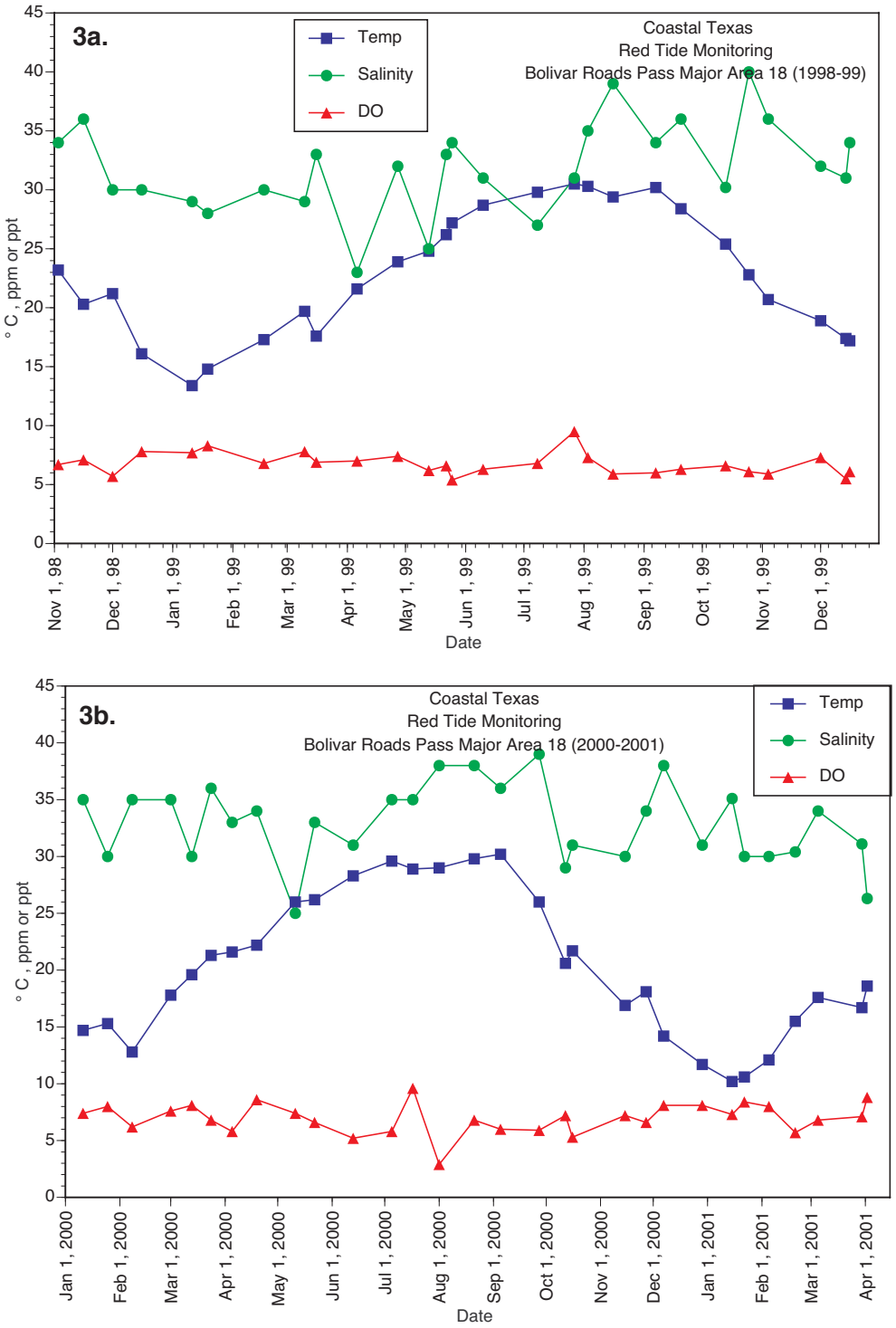
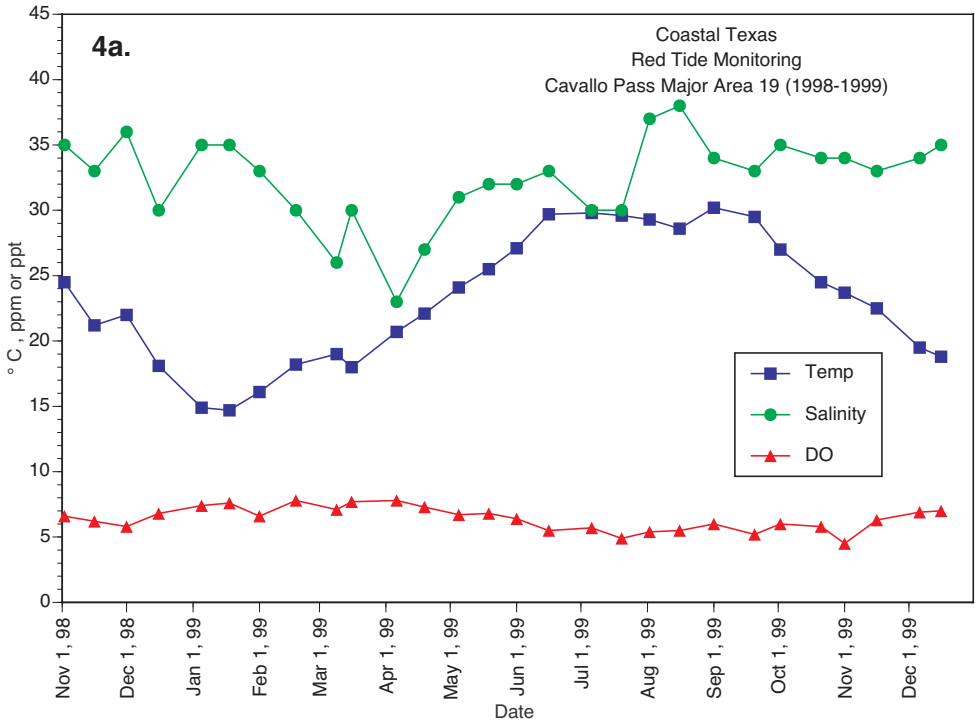


Figure 4. Hydrographic data (temperature, salinity and dissolved oxygen) for Cavallo Pass. Fig. 4a. 1998-1999. Fig. 4b. 2000-2001.



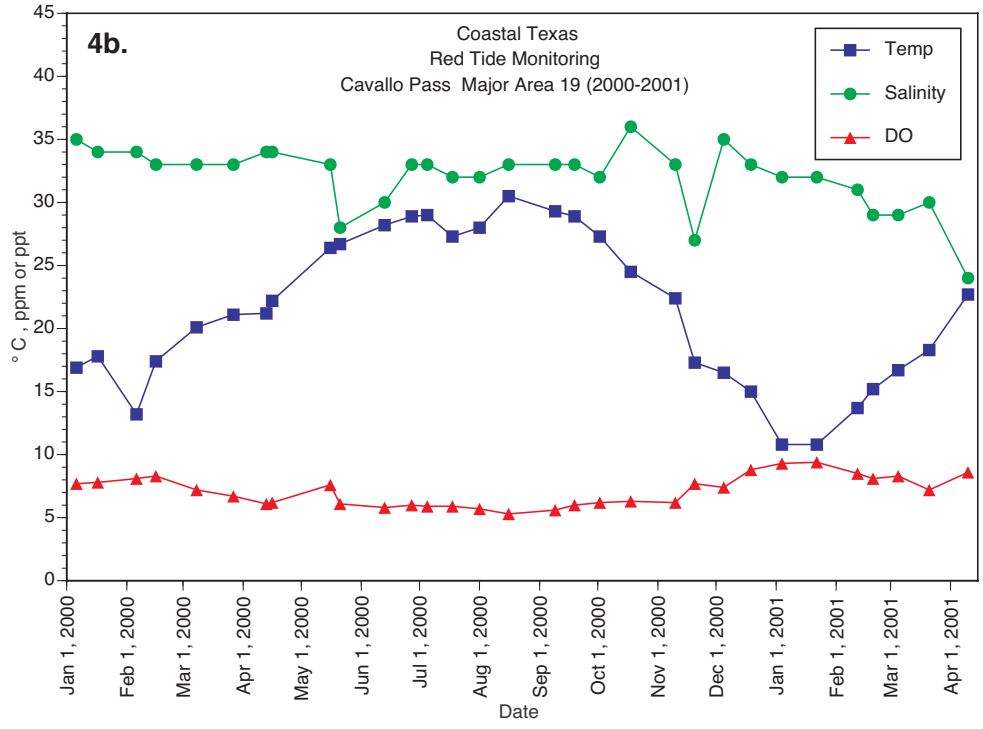
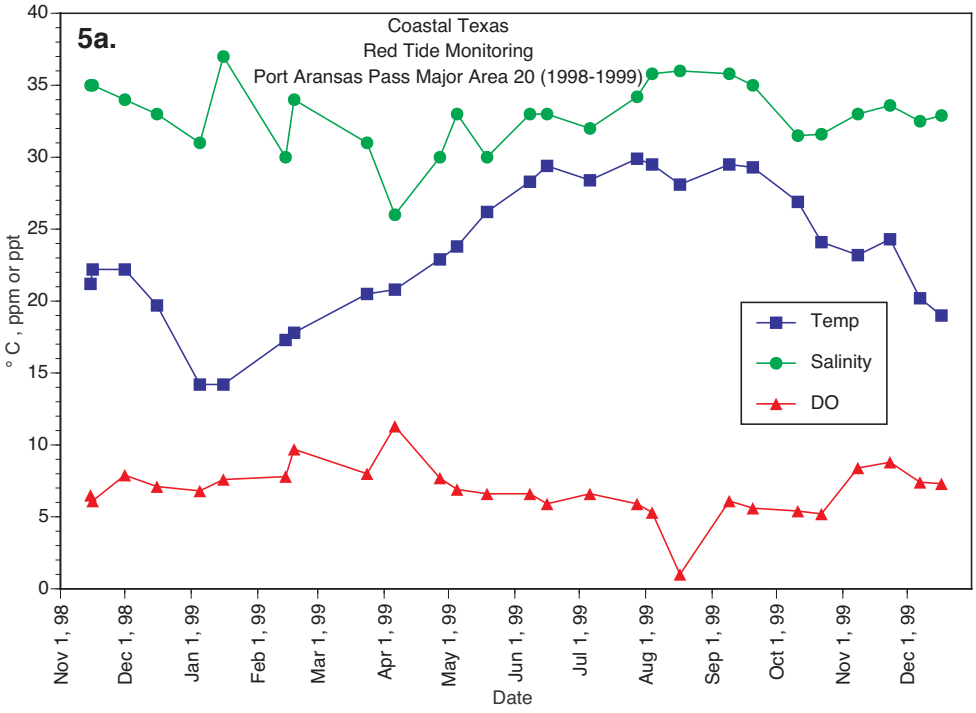



Figure 5. Hydrographic data (temperature, salinity and dissolved oxygen) for Port Aransas Pass. Fig. 5a. 1998-1999. Fig. 5b. 2000-2001.



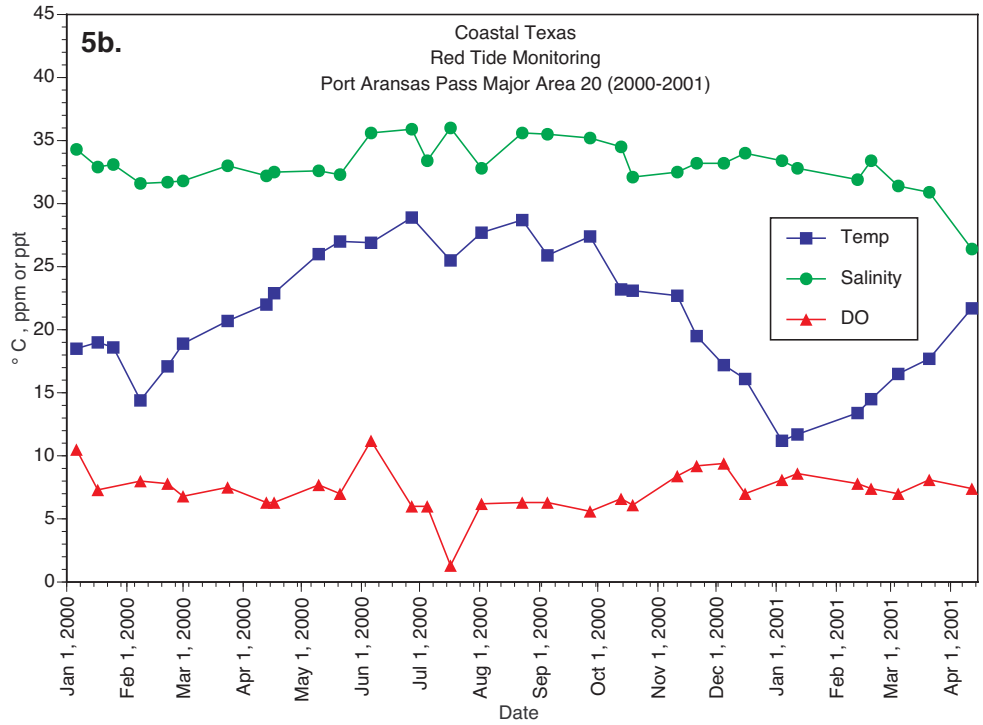
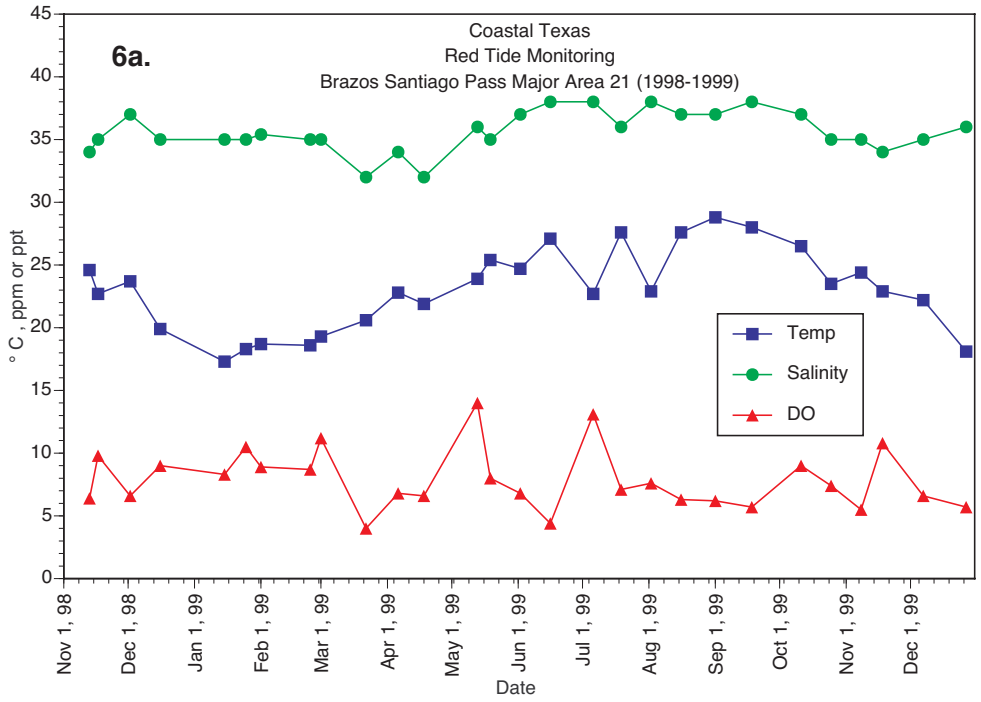
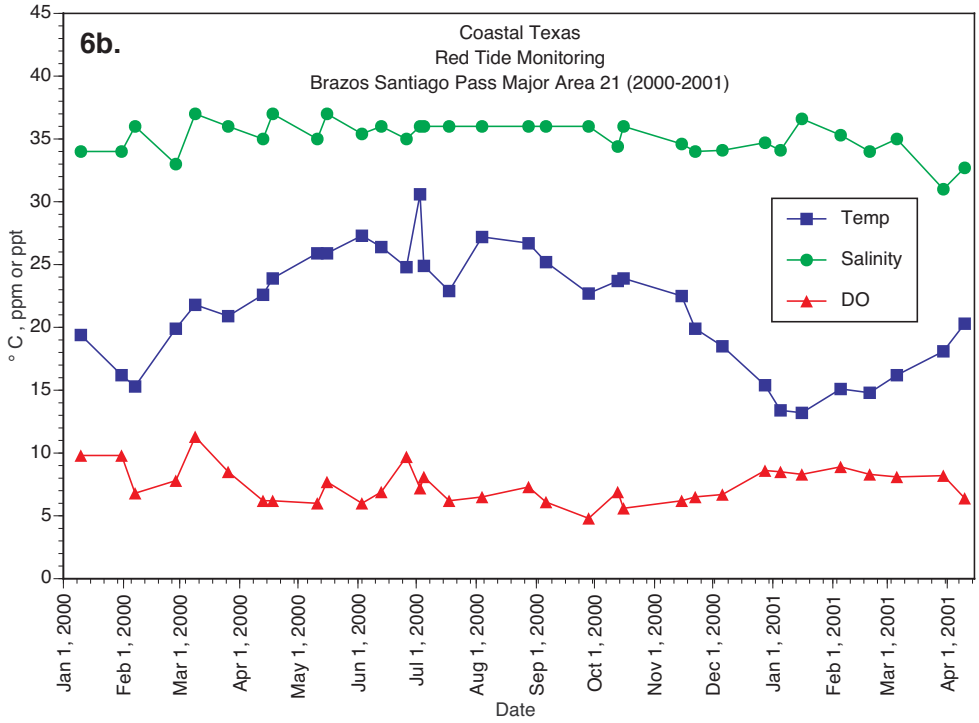
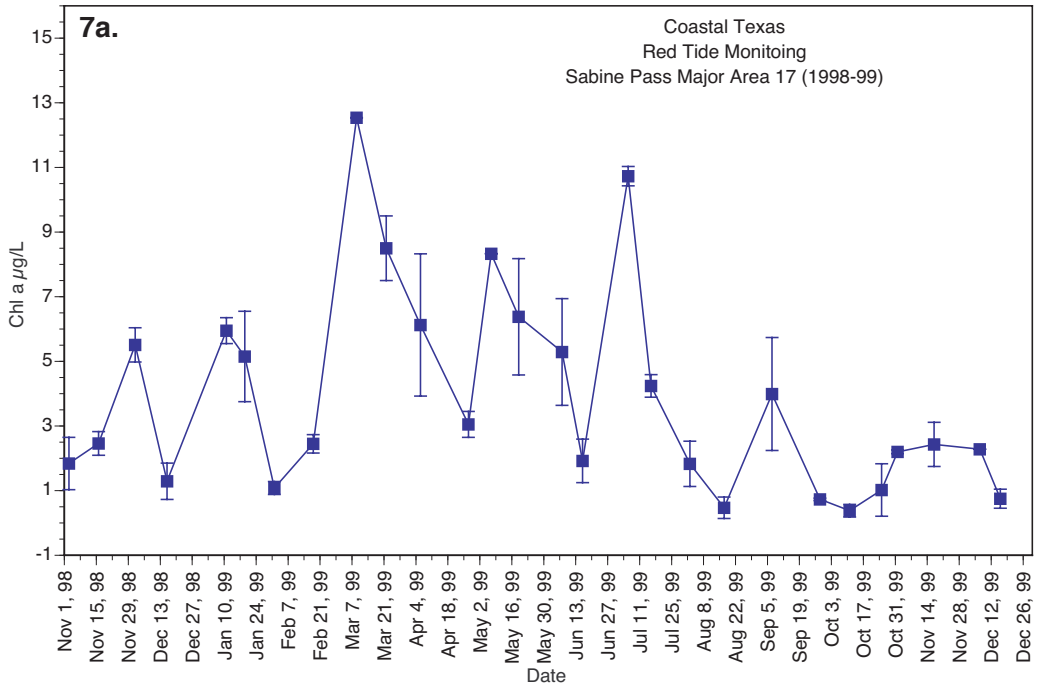



Figure 6. Hydrographic data (temperature, salinity and dissolved oxygen) for Brazos Santiago Pass. Fig. 6a. 1998-1999. Fig. 6b. 2000-2001.



Fi\gure 7. Chlorophyll data for Sabine Pass. Fig. 7a. 1998-1999. Fig. 7b. 2000-2001.



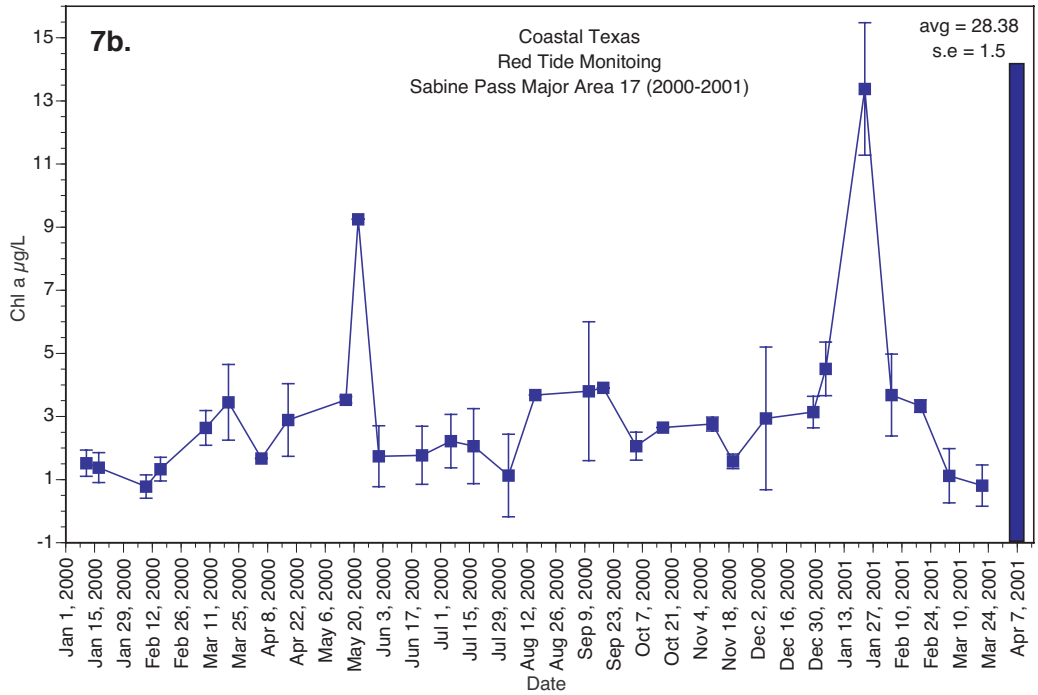
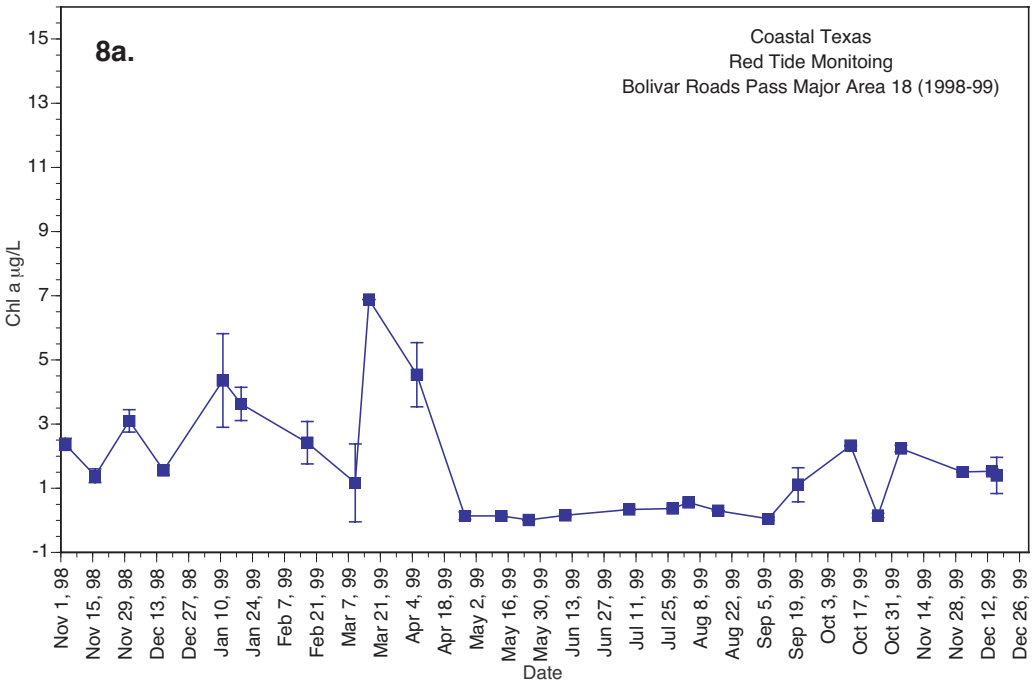



Figure 8. Chlorophyll data for Bolivar Roads Pass. Fig. 8a. 1998-1999. Fig. 8b. 2000-2001.



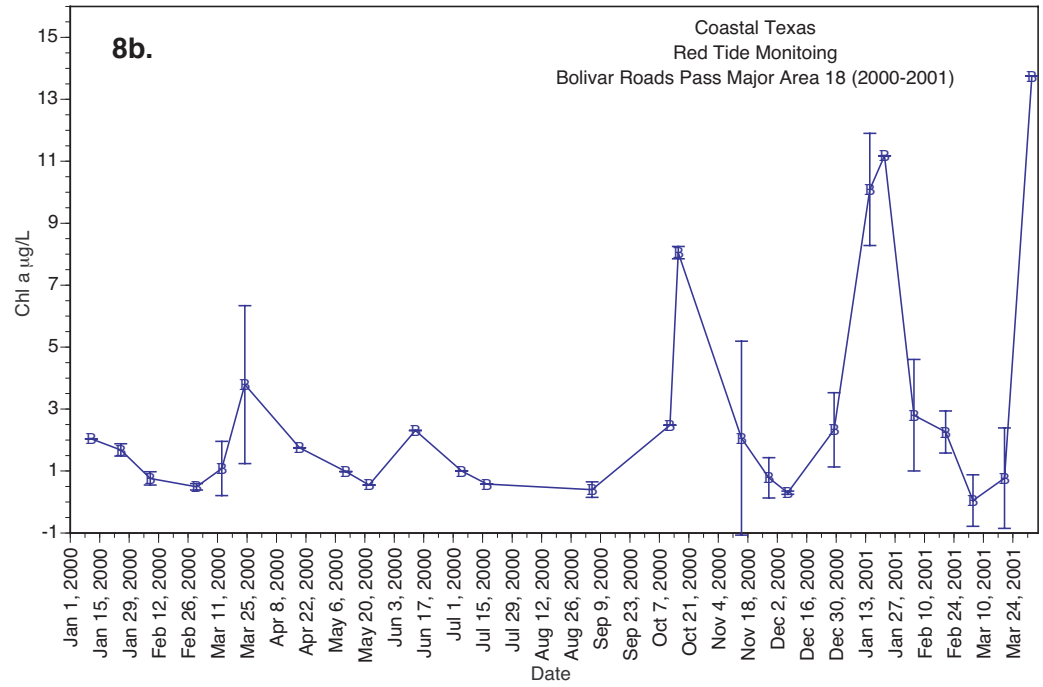
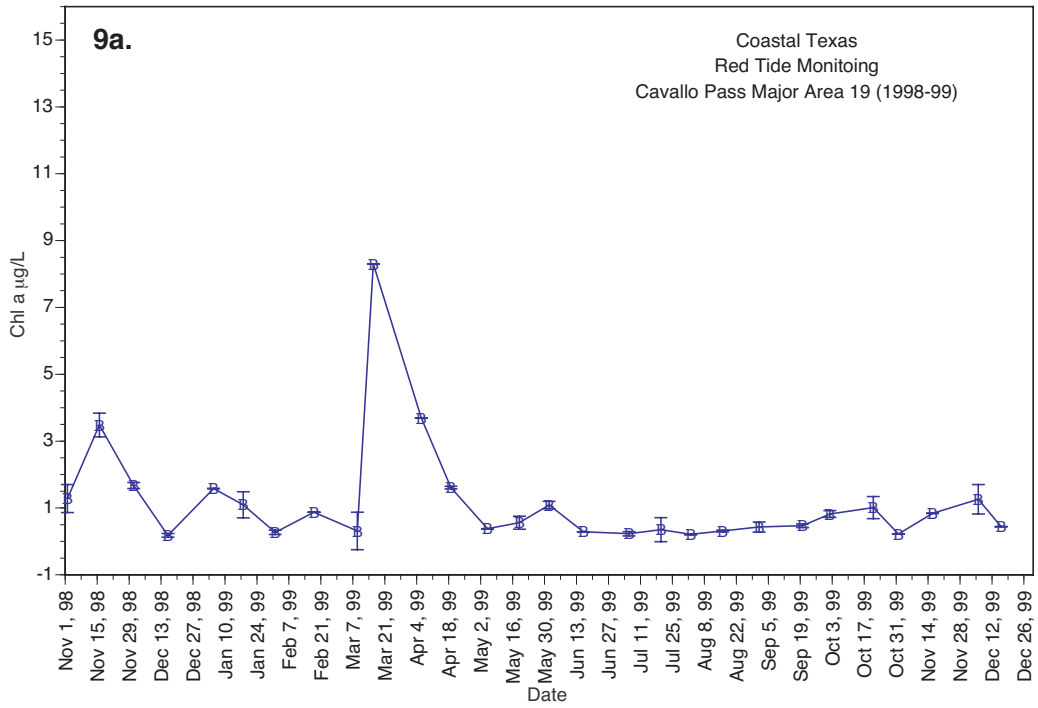



Figure 9. Chlorophyll data for Cavallo Pass. Fig. 9a. 1998-1999. Fig. 9b. 2000-2001



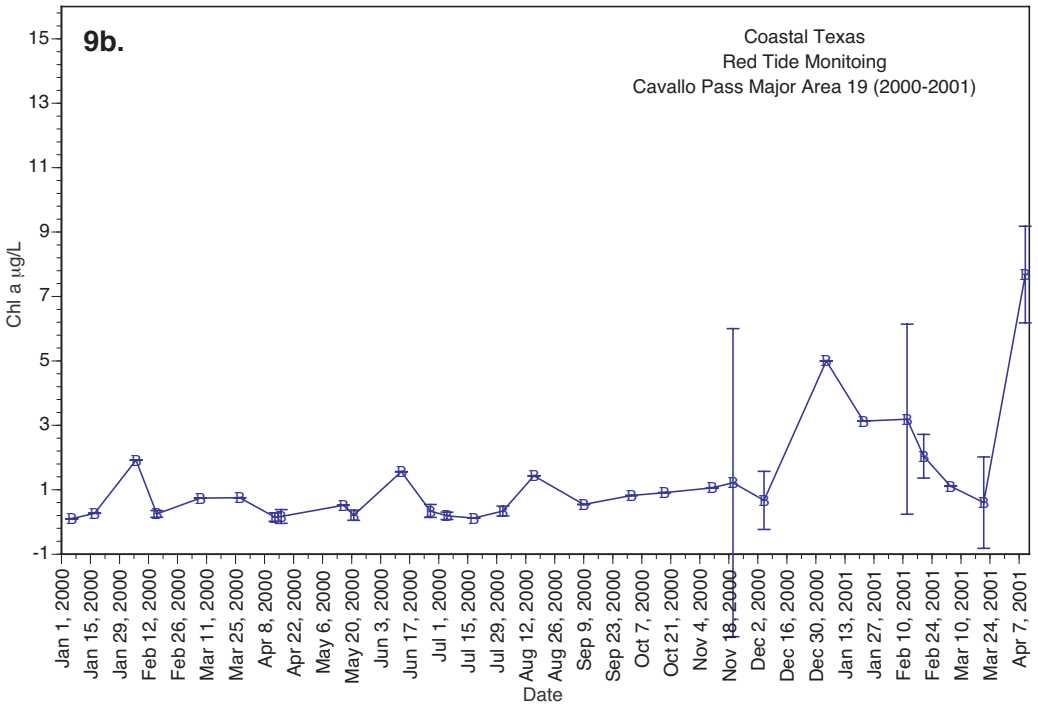
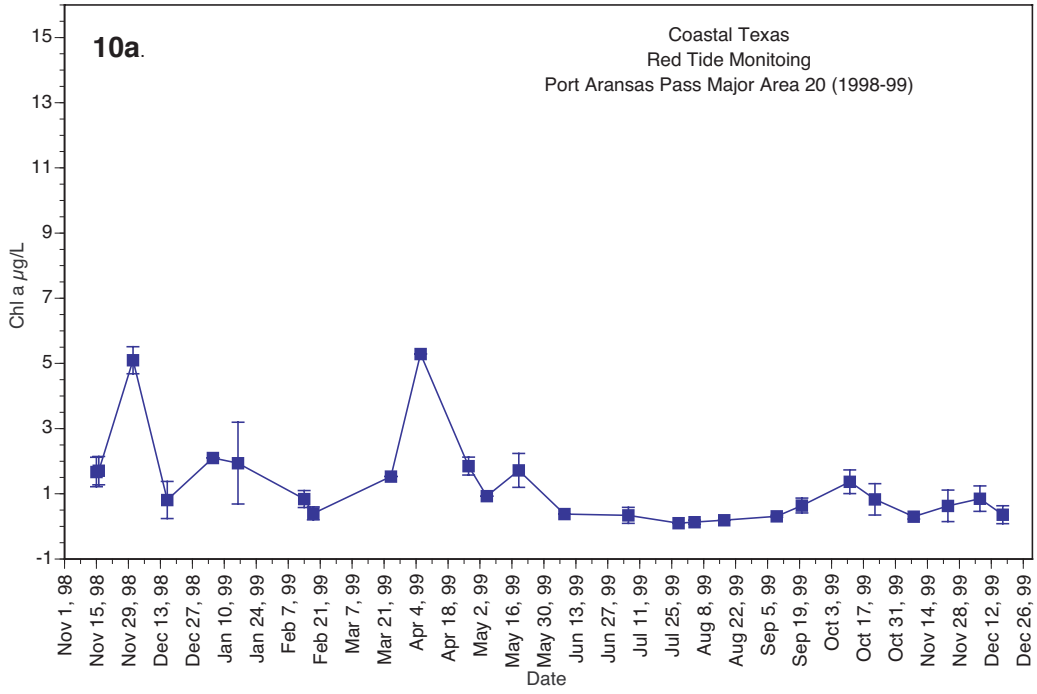



Figure 10. Chlorophyll data for Port Aransas Pass. Fig. 10a. 1998-1999. Fig. 10b. 2000-2001.



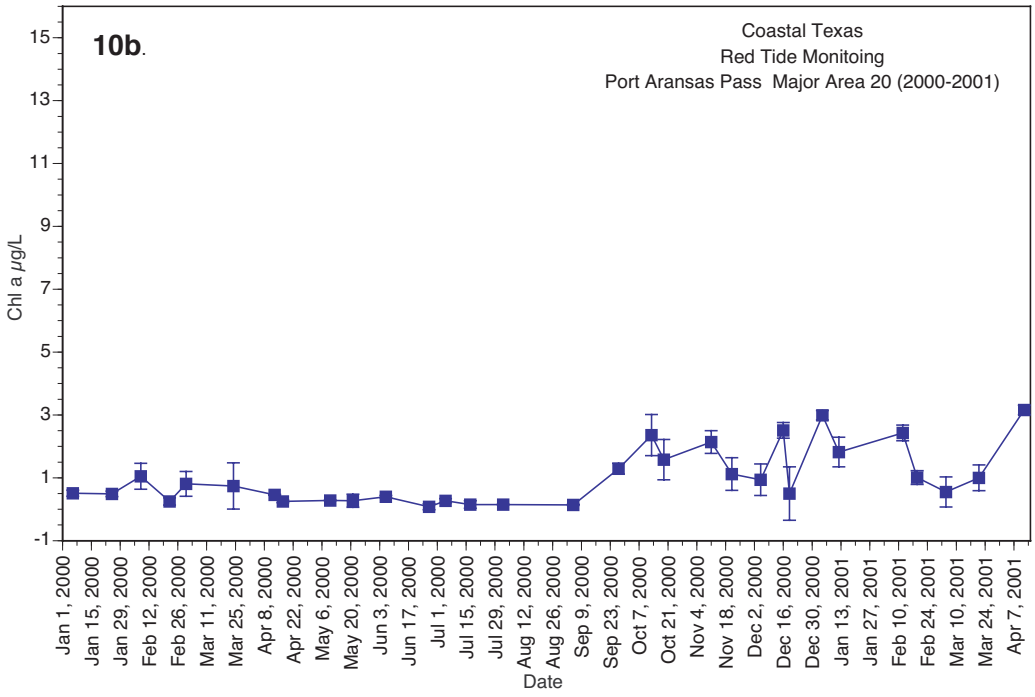
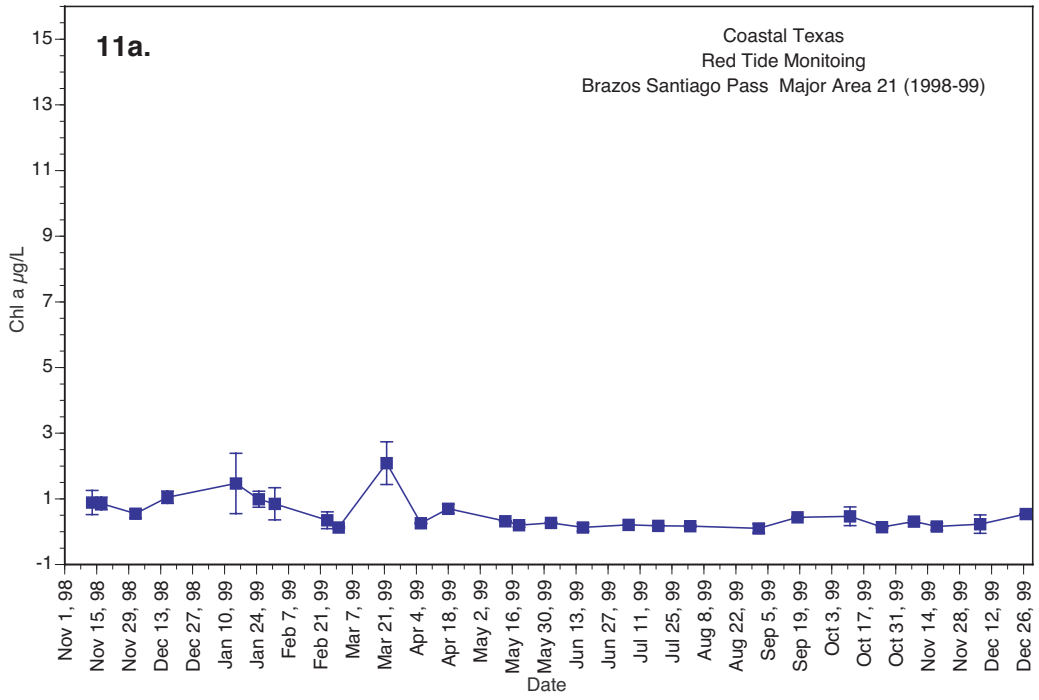



Figure 11. Chlorophyll data for for Brazos Santiago Pass. Fig. 11a. 1998-1999. Fig. 11b. 2000-2001.



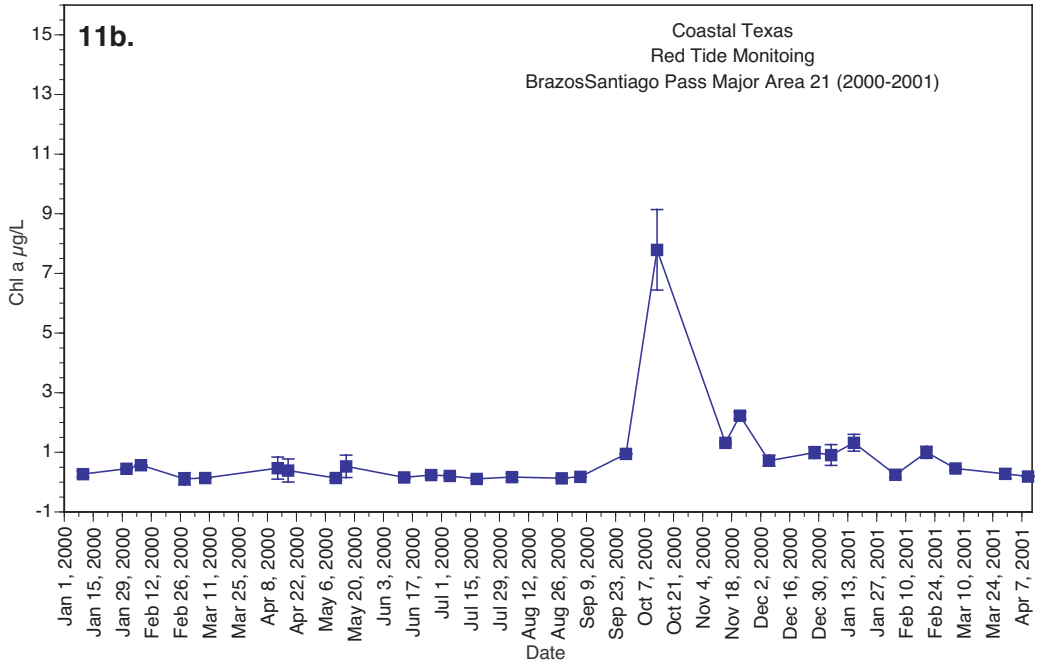
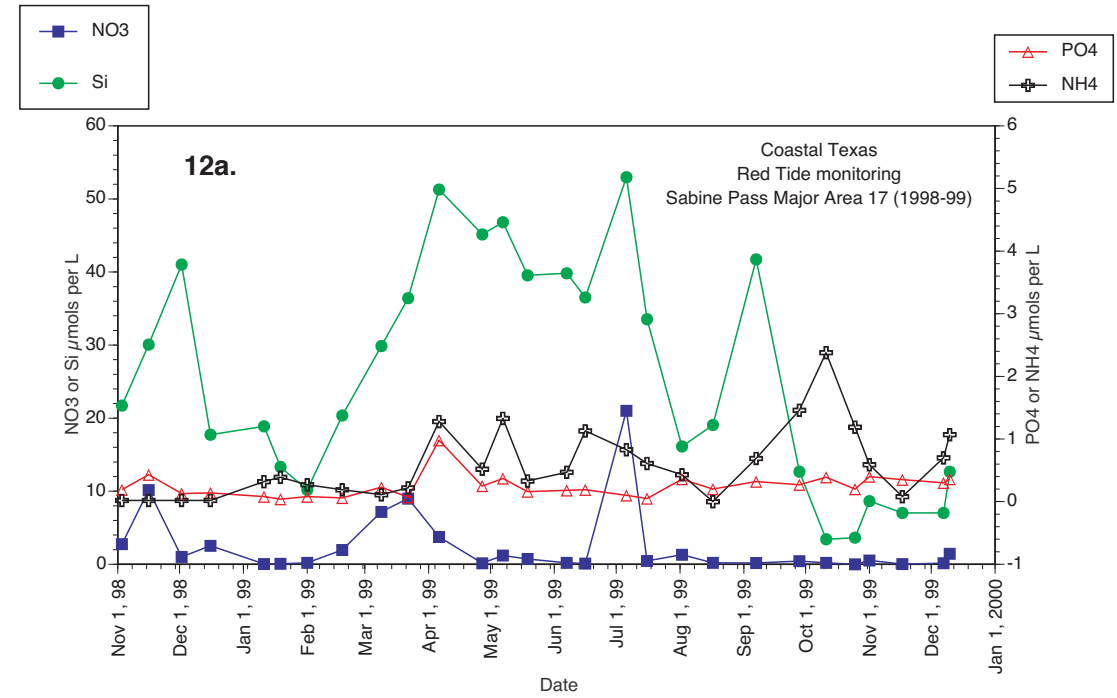



Figure 12. Nutrient data for Sabine Pass. Fig. 12a. 1998-1999. Fig. 12b. 2000-2001.



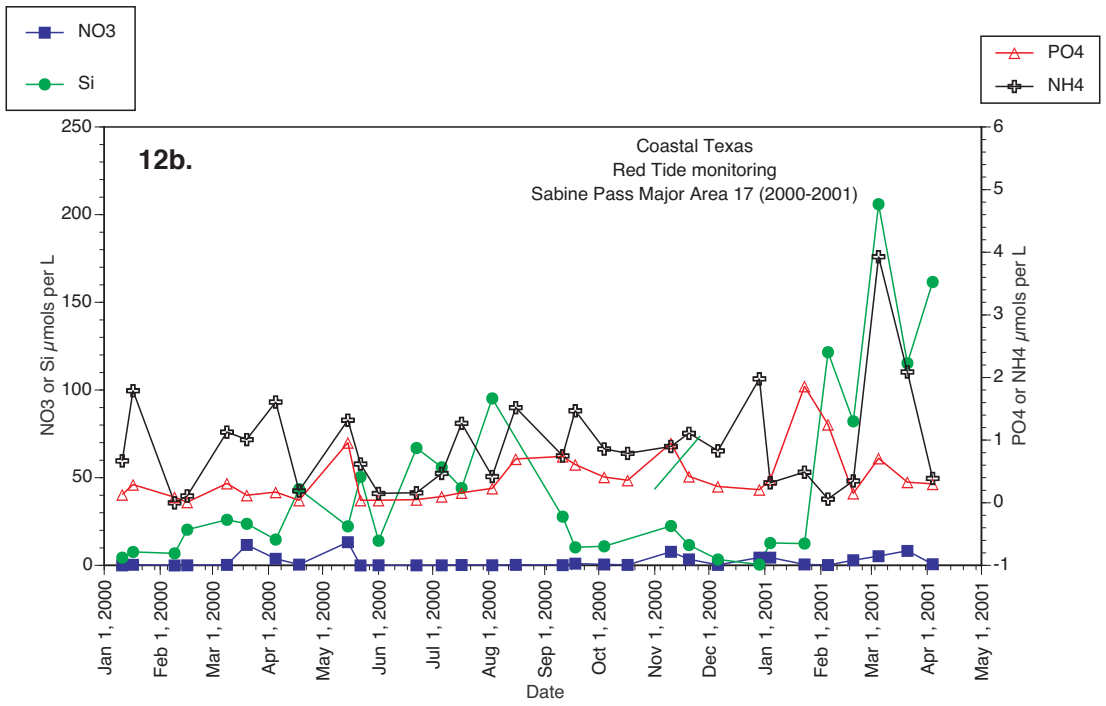
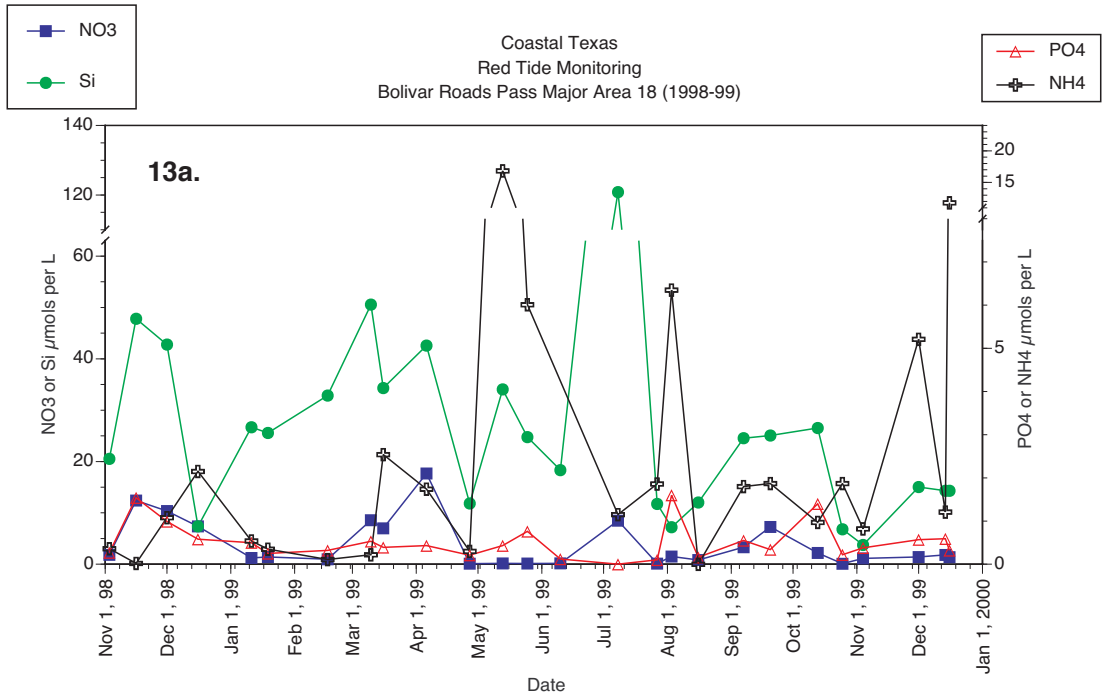



Figure 13. Nutrient data for Bolivar Roads Pass. Fig. 13a. 1998-1999. Fig. 13b. 2000-2001. Note scale break on left axis.



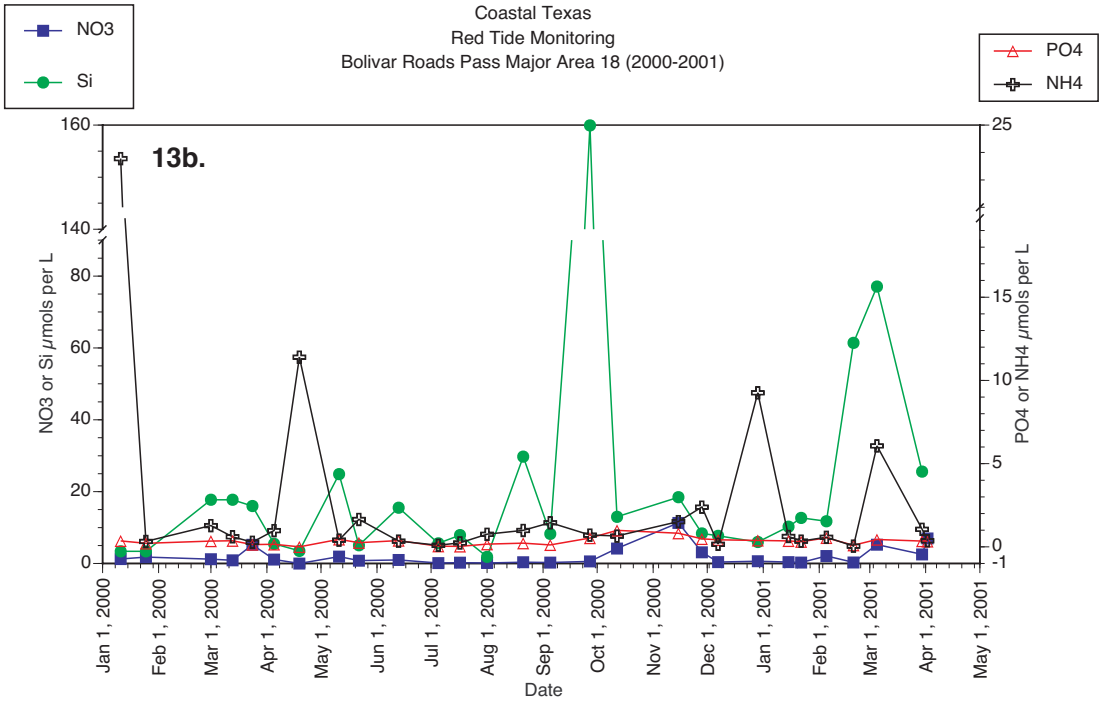
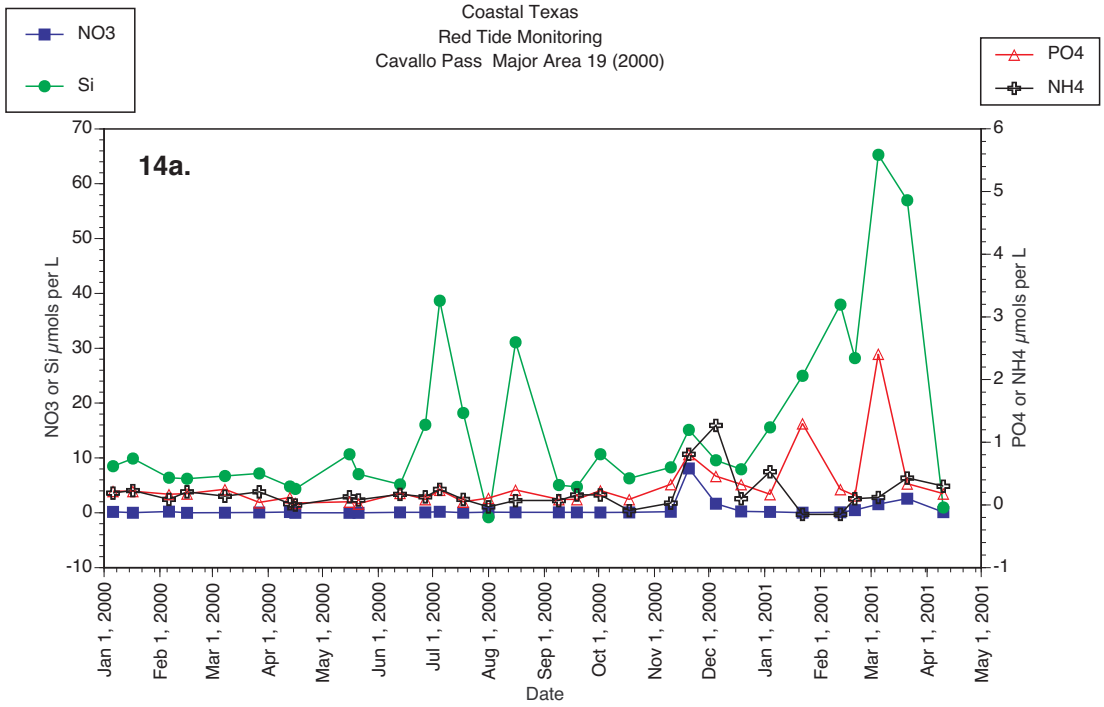



Figure 14. Nutrient data for Cavallo Pass. Fig. 14a. 1998-1999. Fig. 14b. 2000-2001.



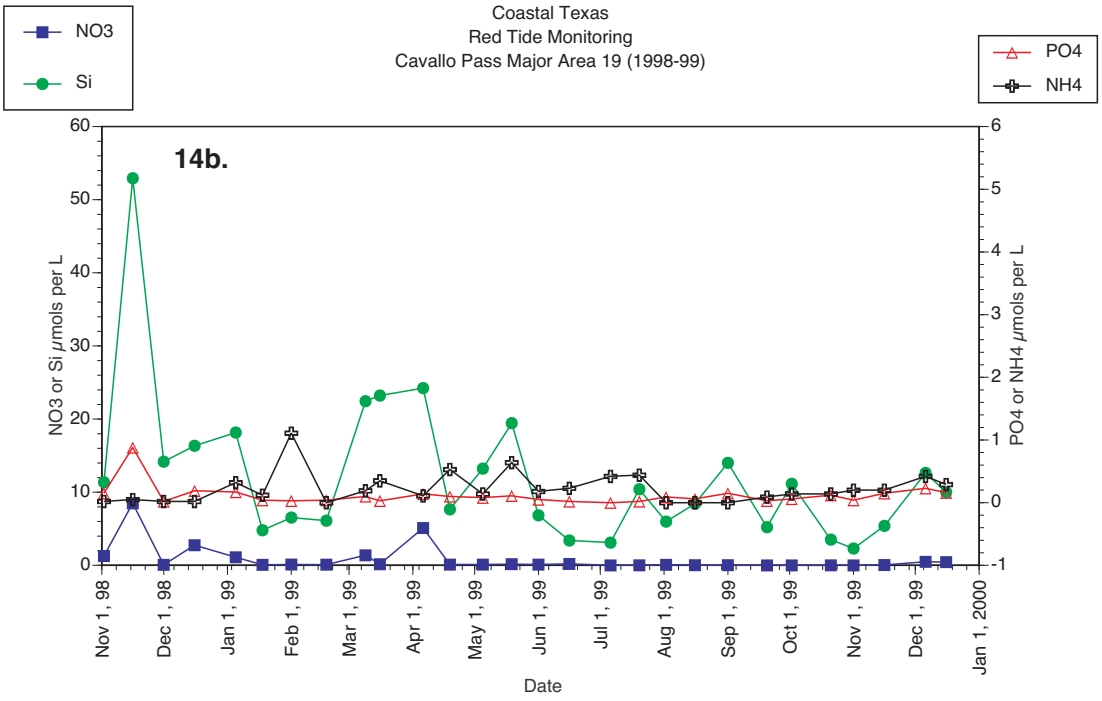
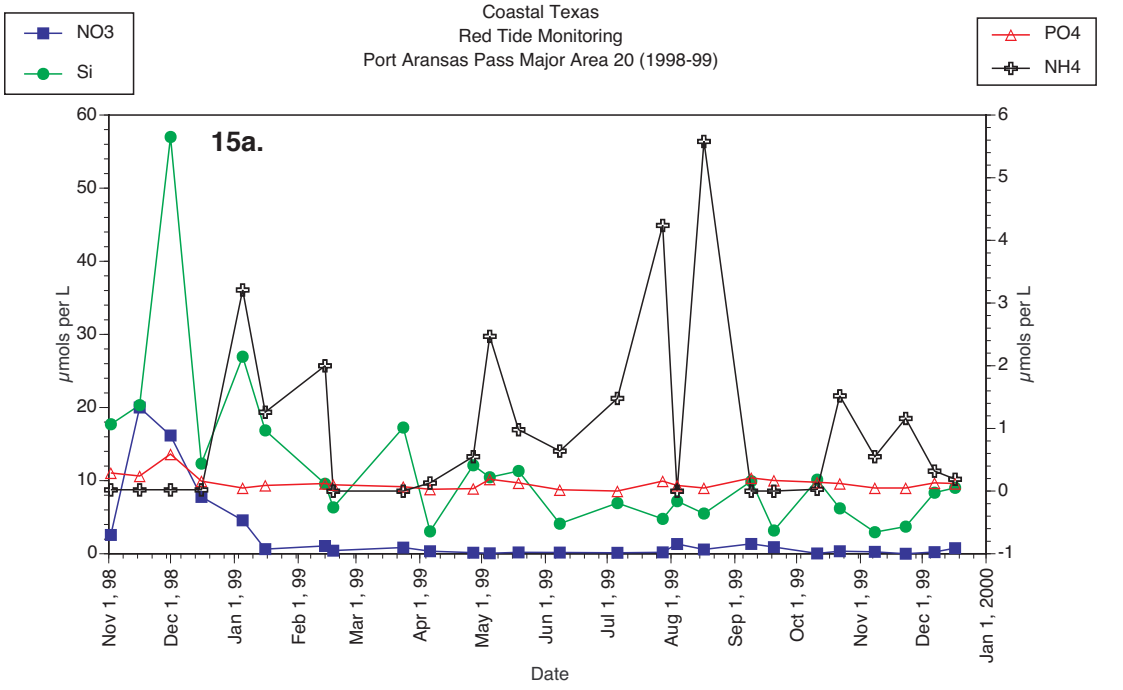



Figure 15. Nutrient data for Port Aransas Pass. Fig. 15a. 1998-1999. Fig. 15b. 2000-2001.



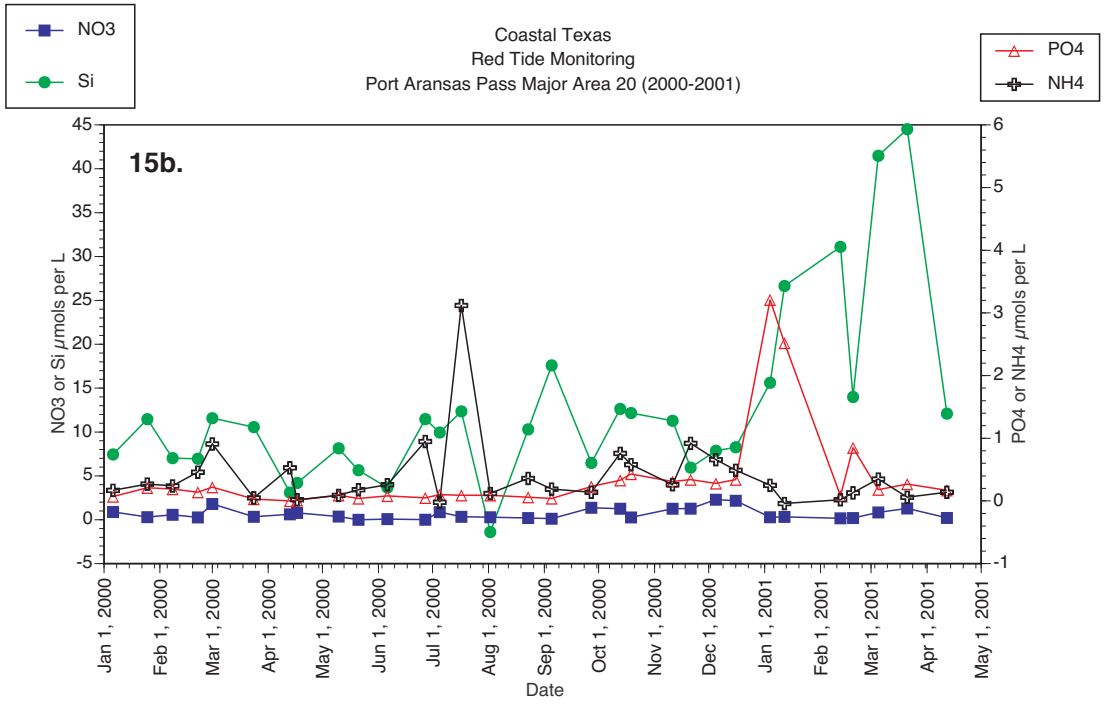
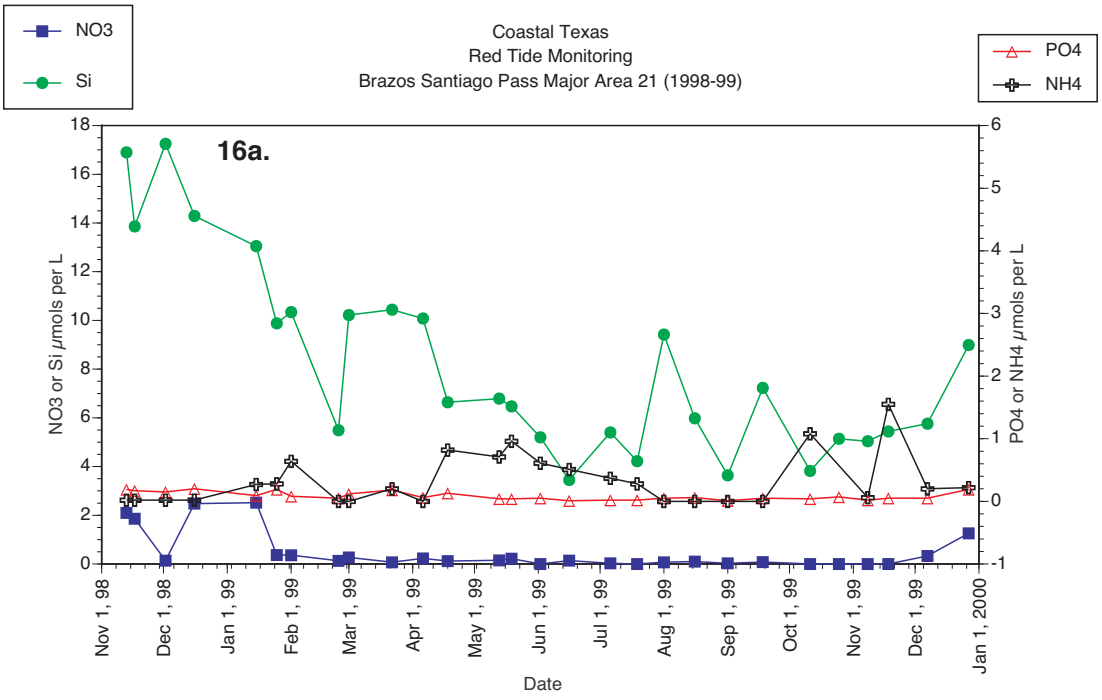



Figure 16. Nutrient data for Brazos Santiago Pass. Fig. 16a. 1998-1999. Fig. 16b. 2000-2001.



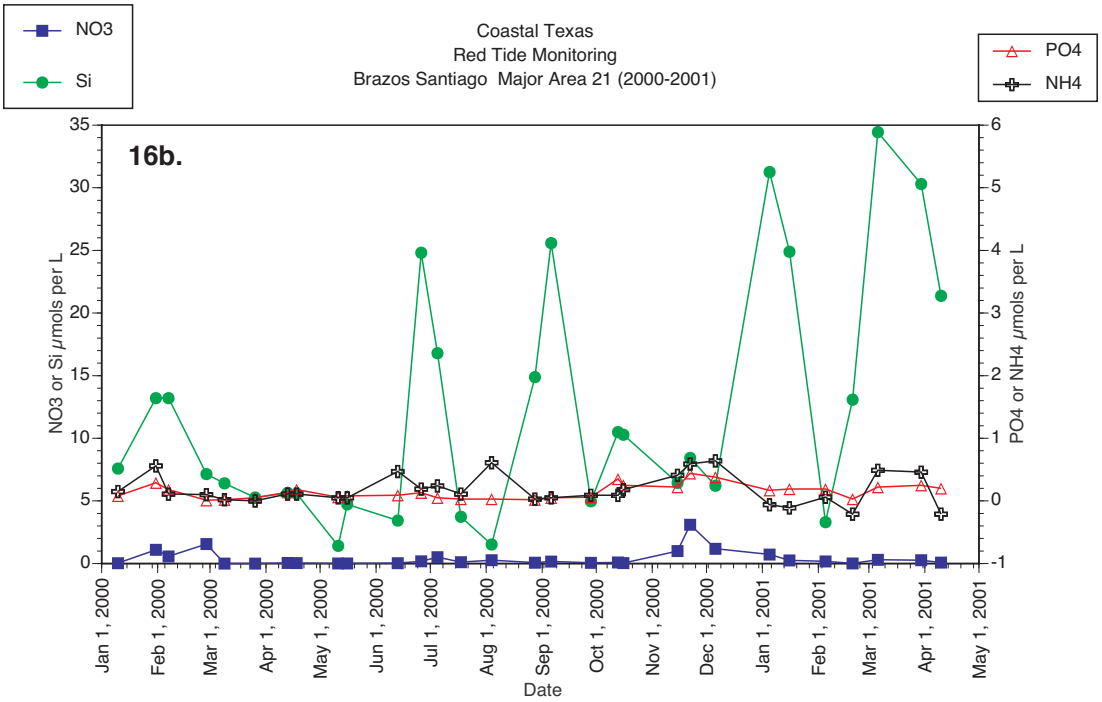
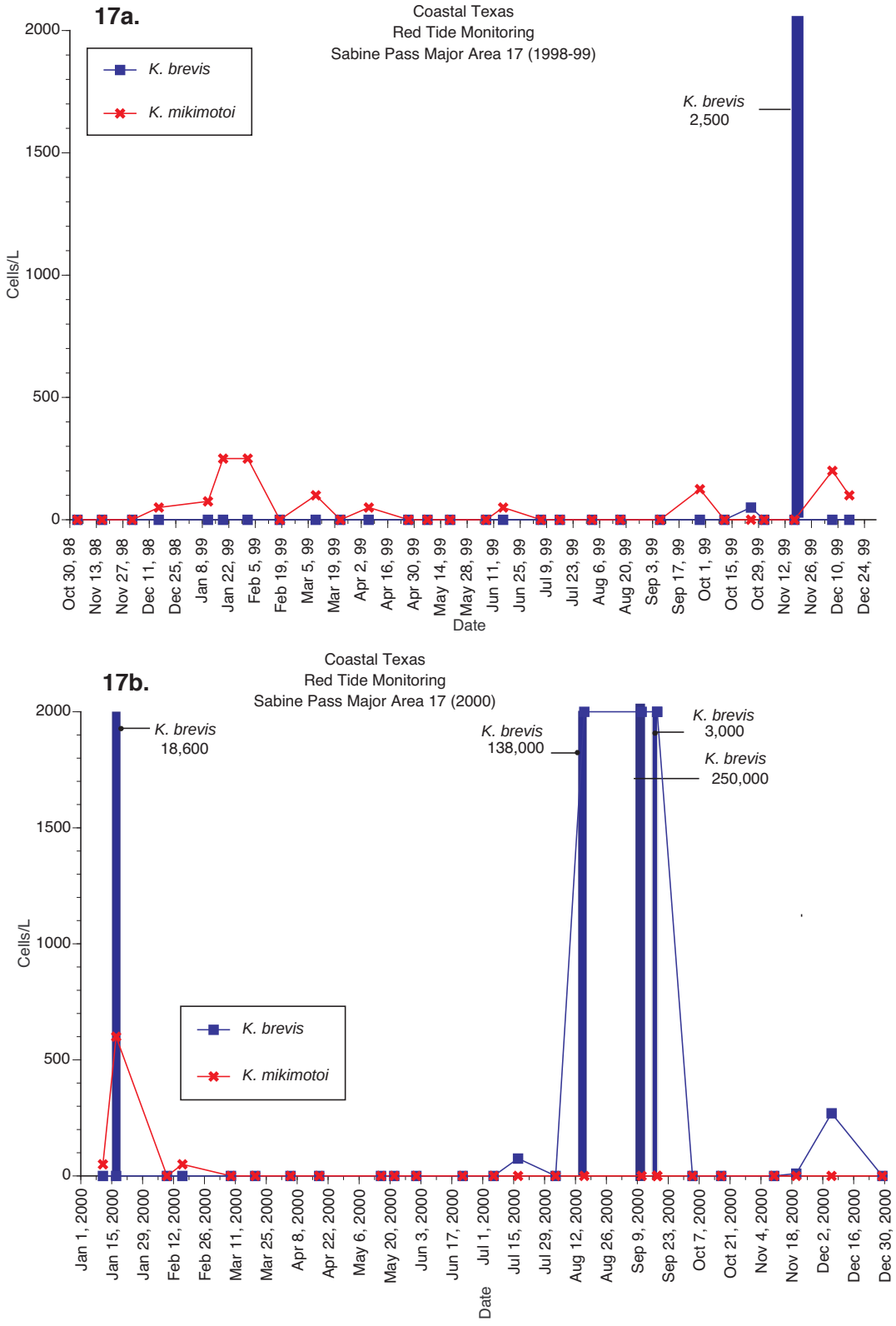



Figure 17. Cell count data for *K. brevis* and *K. mikimotoi* at Sabine Pass. Fig. 17a. 1998-1999. Fig. 17b. 2000. Fig. 17c. 2001.



**17c.**

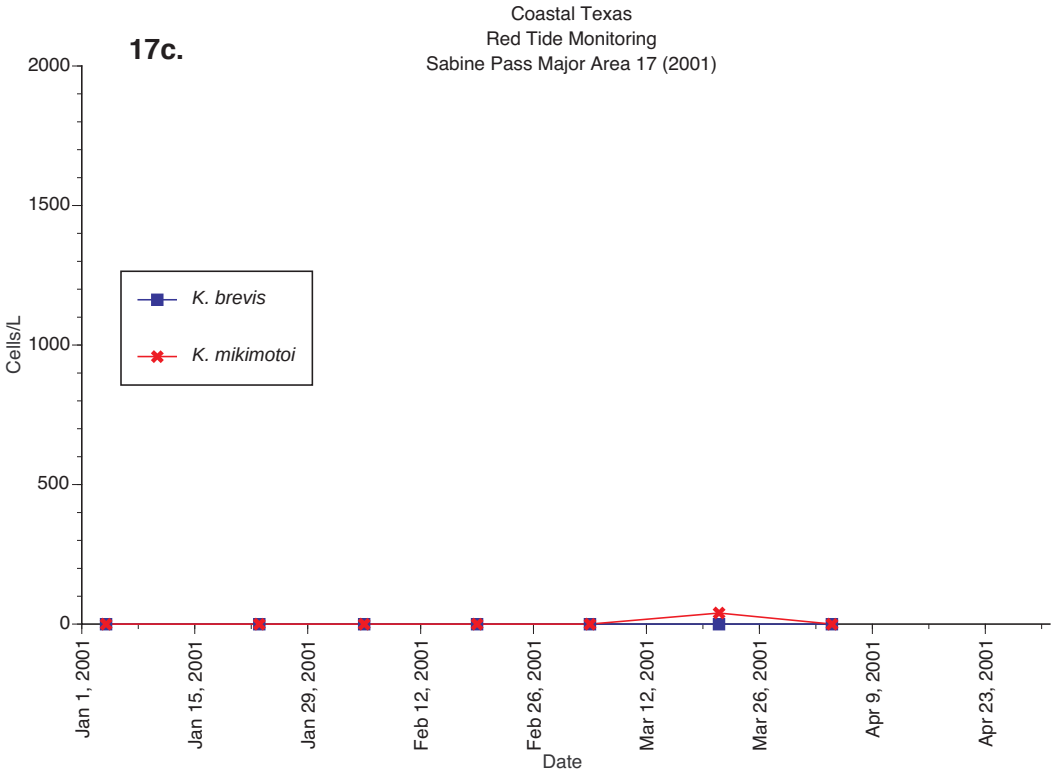
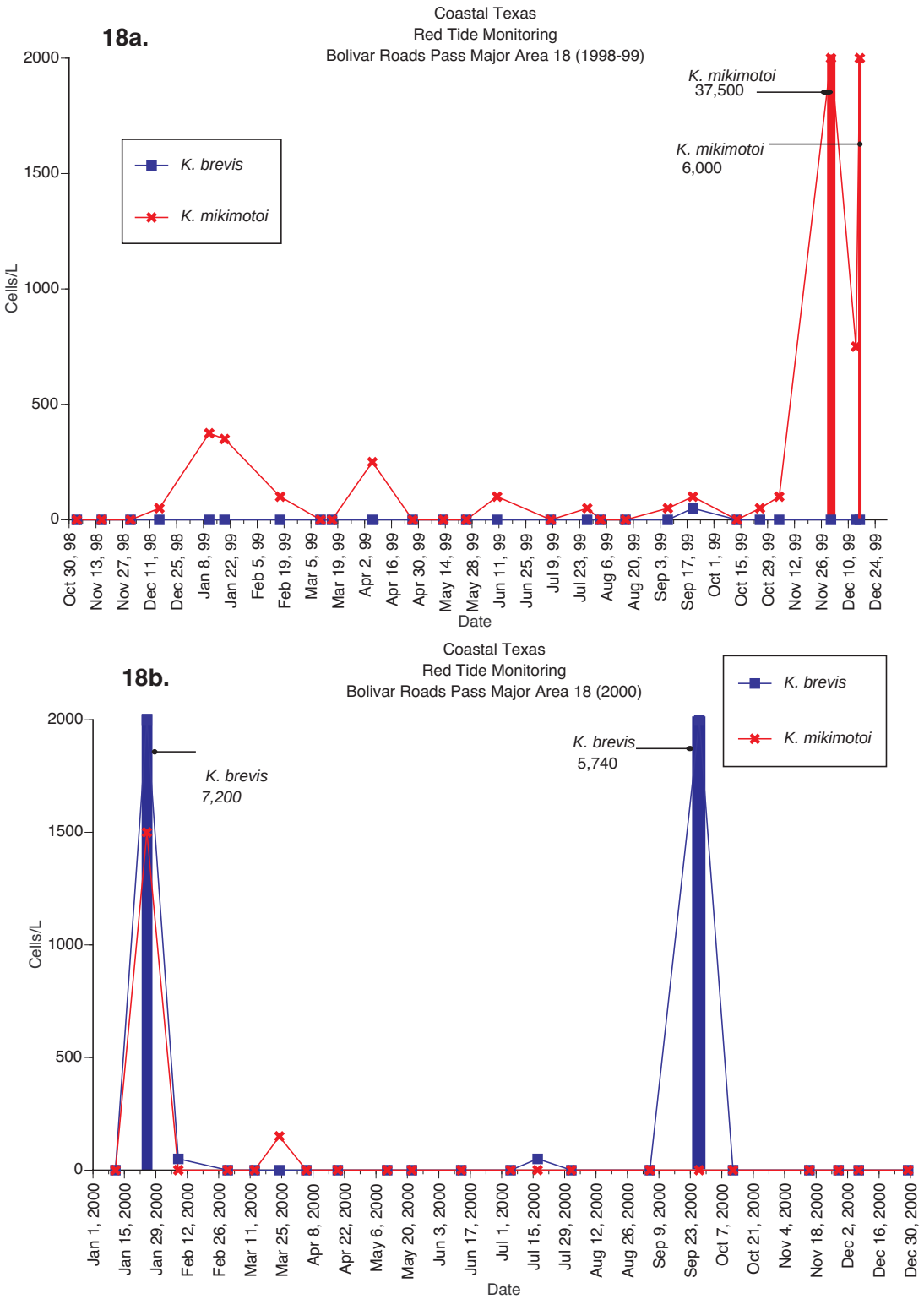

Coastal Texas
Red Tide Monitoring
Sabine Pass Major Area 17 (2001)
2000
1500
1000
500
0
Cells/L
K. brevis
K. mikimotoi
Jan 1, 2001
Jan 15, 2001
Jan 29, 2001
Feb 12, 2001
Feb 26, 2001
Mar 12, 2001
Mar 26, 2001
Apr 9, 2001
Apr 23, 2001
Date

Figure 18. Cell count data for *K. brevis* and *K. mikimotoi* at Bolivar Roads Pass. Fig. 18a. 1998-1999. Fig. 18b. 2000. Fig. 18c. 2001.



**18c.**

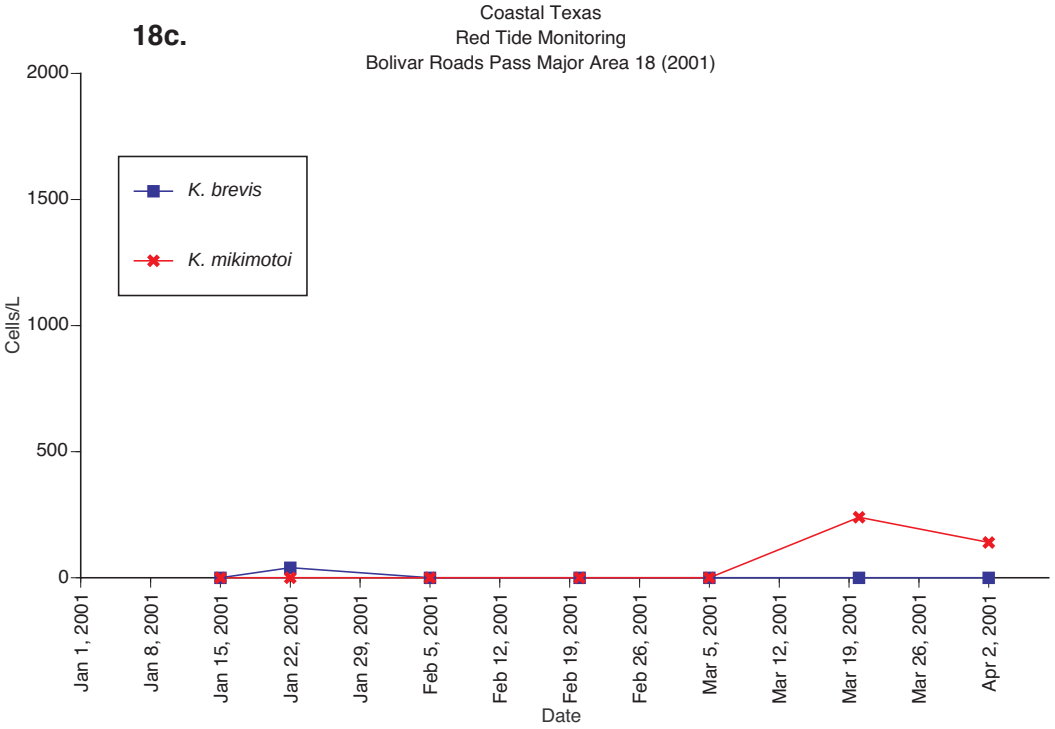
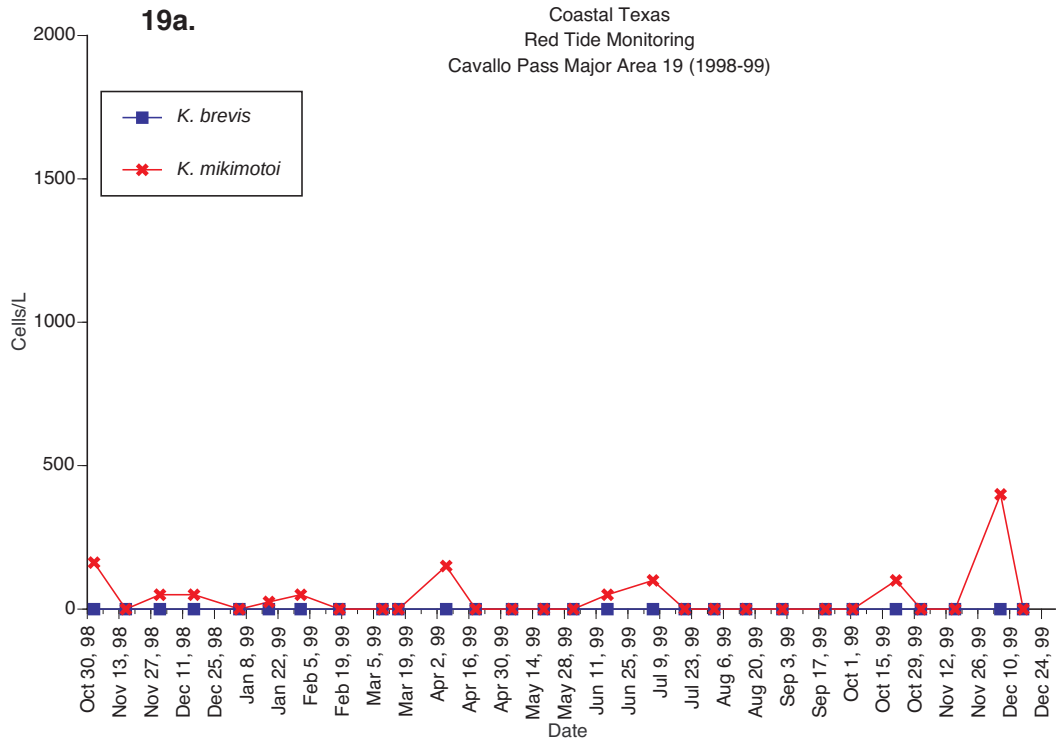
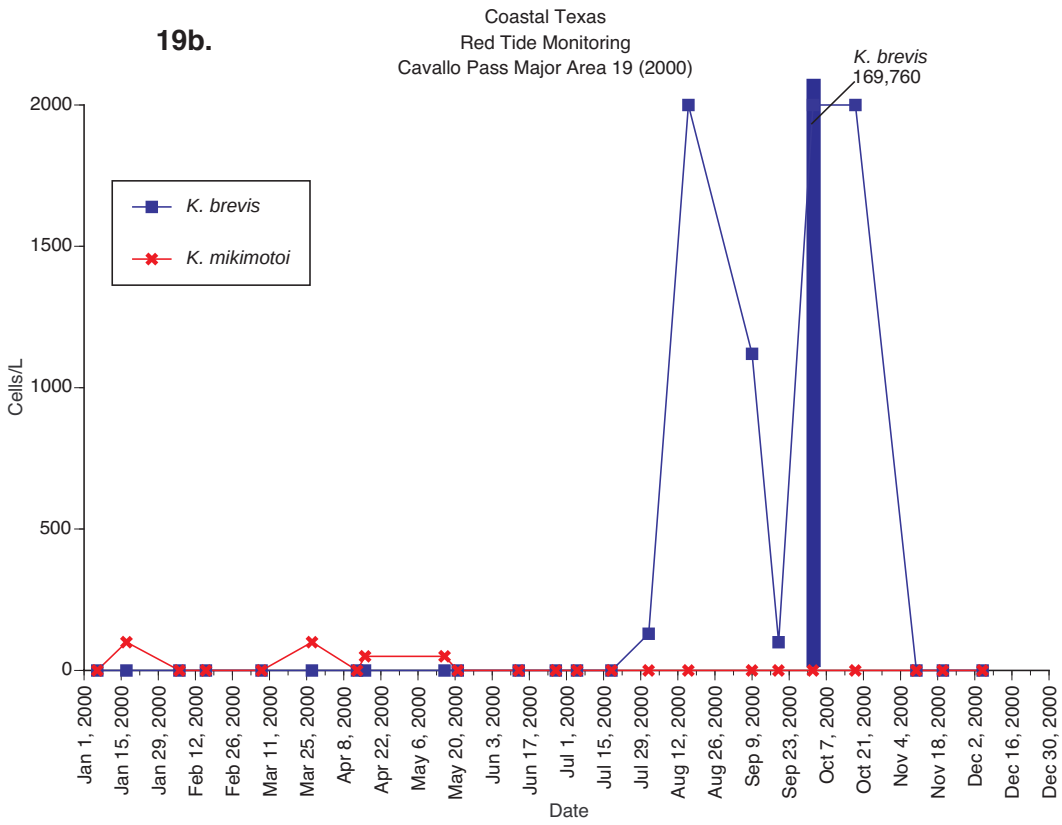

Coastal Texas
Red Tide Monitoring
Bolivar Roads Pass Major Area 18 (2001)
2000
1500
1000
500
0
Cells/L
K. brevis
K. mikimotoi
Jan 1, 2001
Jan 8, 2001
Jan 15, 2001
Jan 22, 2001
Jan 29, 2001
Feb 5, 2001
Feb 12, 2001
Feb 19, 2001
Feb 26, 2001
Mar 5, 2001
Mar 12, 2001
Mar 19, 2001
Mar 26, 2001
Apr 2, 2001
Date

Figure 19. Cell count data for *K. brevis* and *K. mikimotoi* at Cavallo Pass. Fig. 17a. 1998-1999. Fig. 19b. 2000. Fig. 19c. 2001.



**19c.**

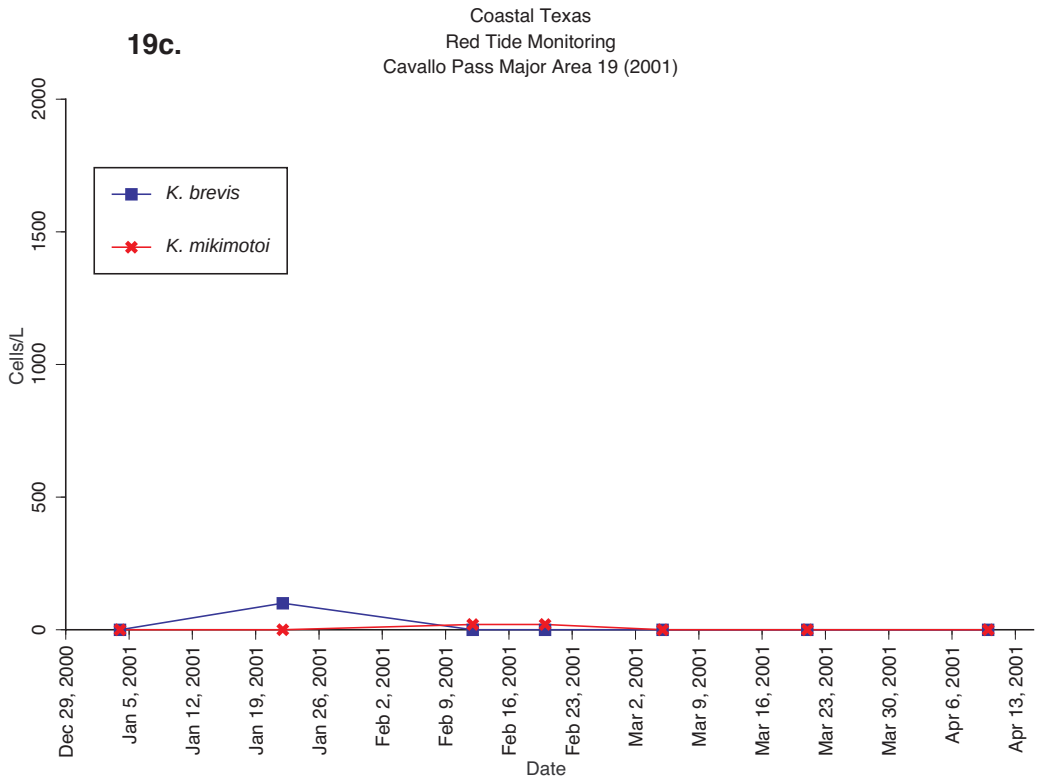
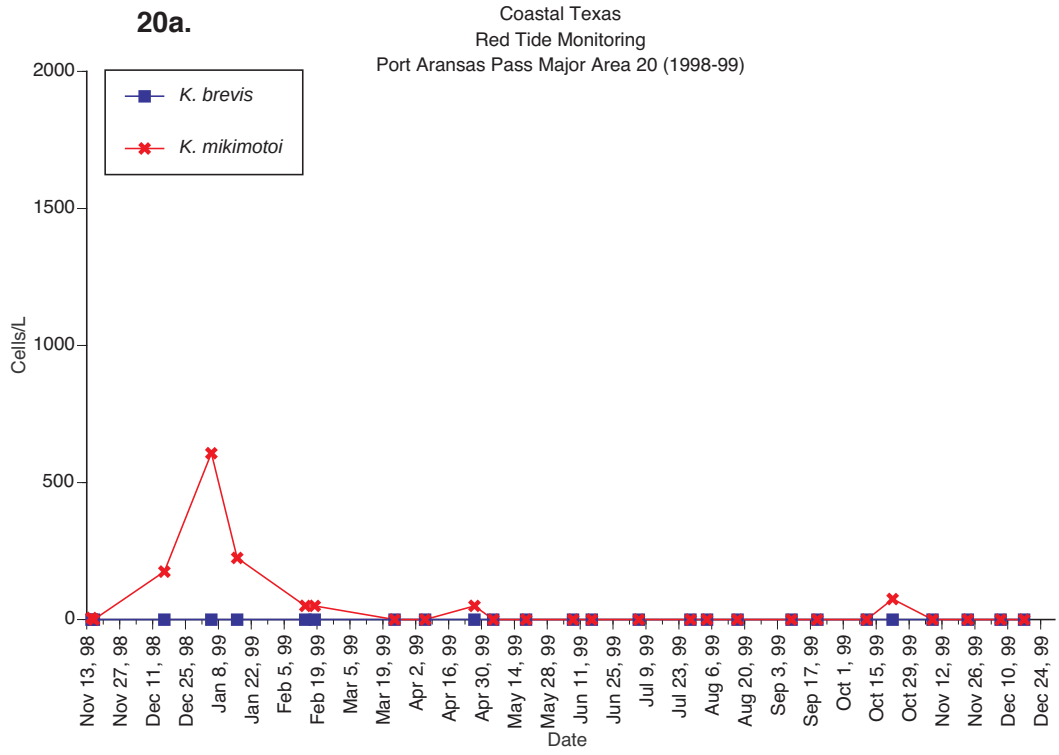
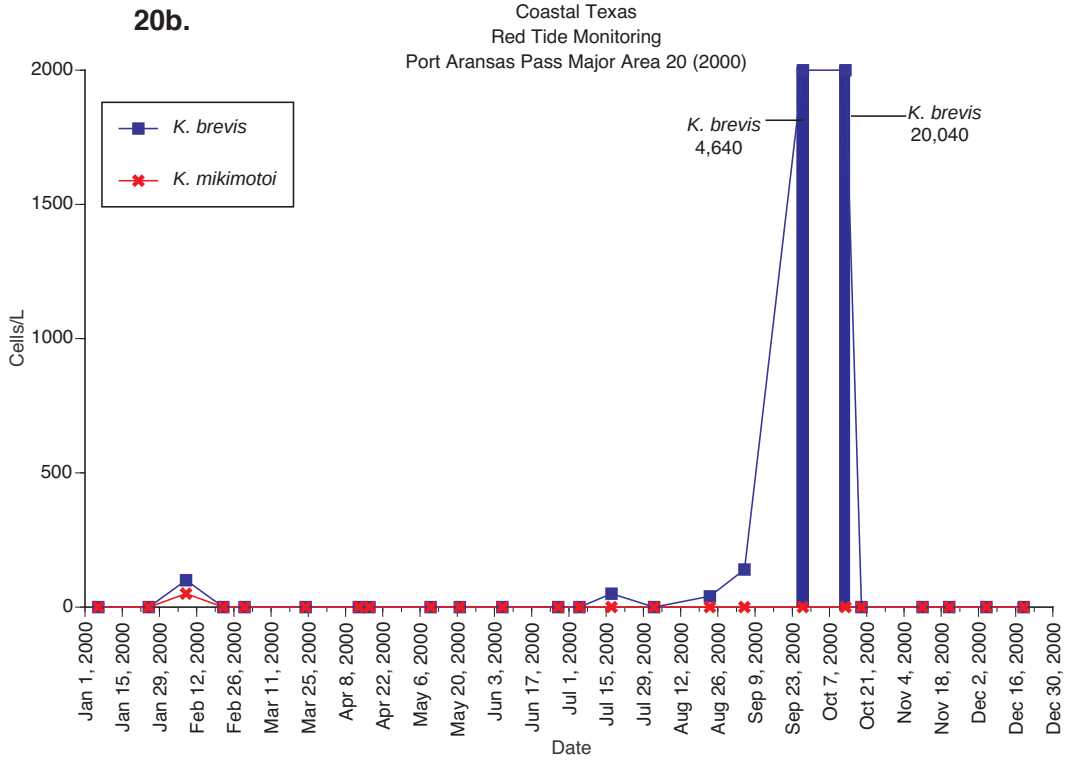

Coastal Texas
Red Tide Monitoring
Cavallo Pass Major Area 19 (2001)
K. brevis
K. mikimotoi
Cells/L
0
500
1000
1500
2000
Dec 29, 2000
Jan 5, 2001
Jan 12, 2001
Jan 19, 2001
Jan 26, 2001
Feb 2, 2001
Feb 9, 2001
Feb 16, 2001
Feb 23, 2001
Mar 2, 2001
Mar 9, 2001
Mar 16, 2001
Mar 23, 2001
Mar 30, 2001
Apr 6, 2001
Apr 13, 2001
Date

Figure 20. Cell count data for *K. brevis* and *K. mikimotoi* at Port Aransas Pass. Fig. 20a. 1998-1999. Fig. 20b. 2000. Fig. 20c. 2001.



**20c.**

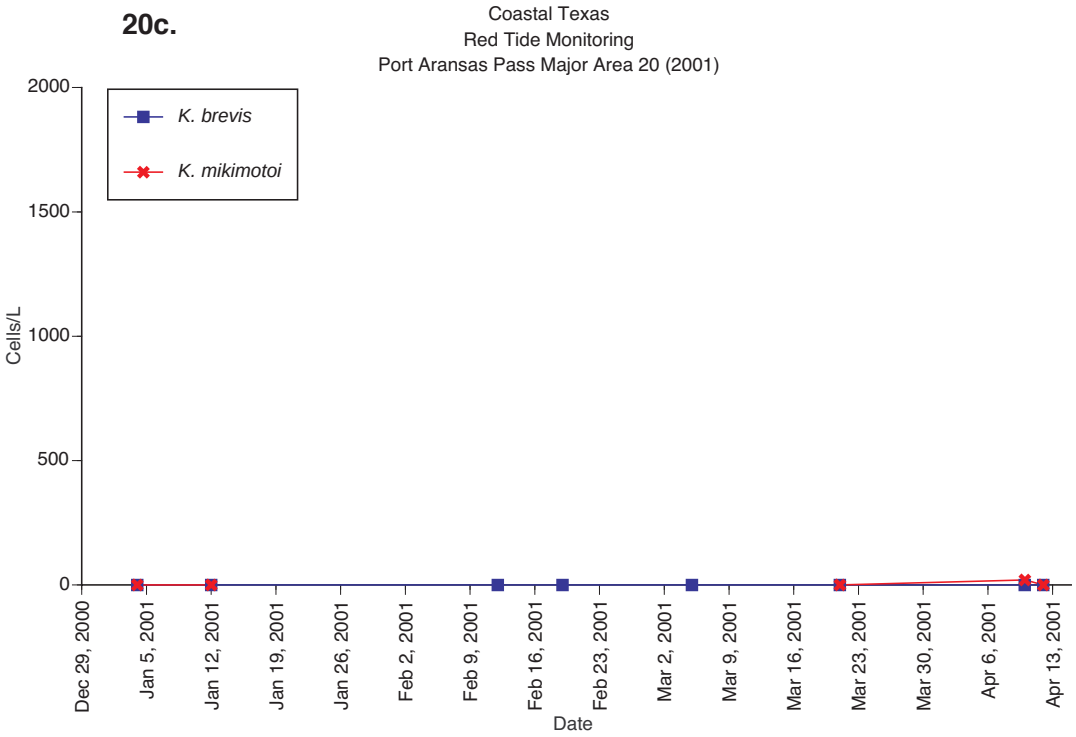
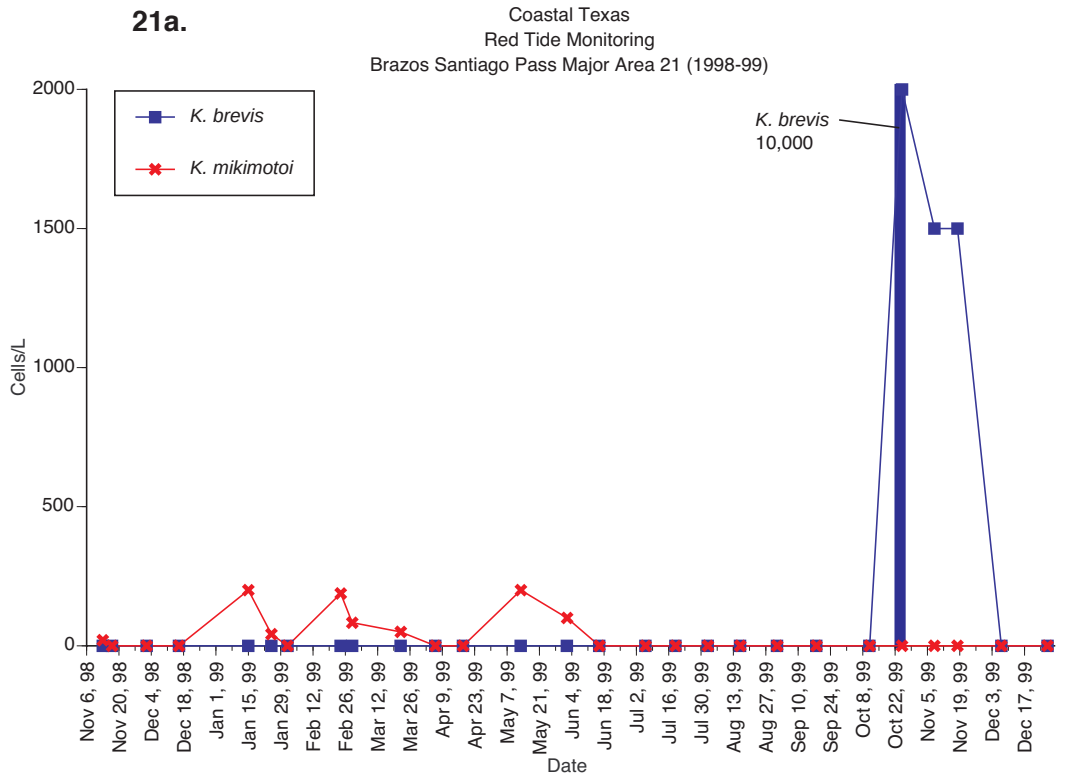
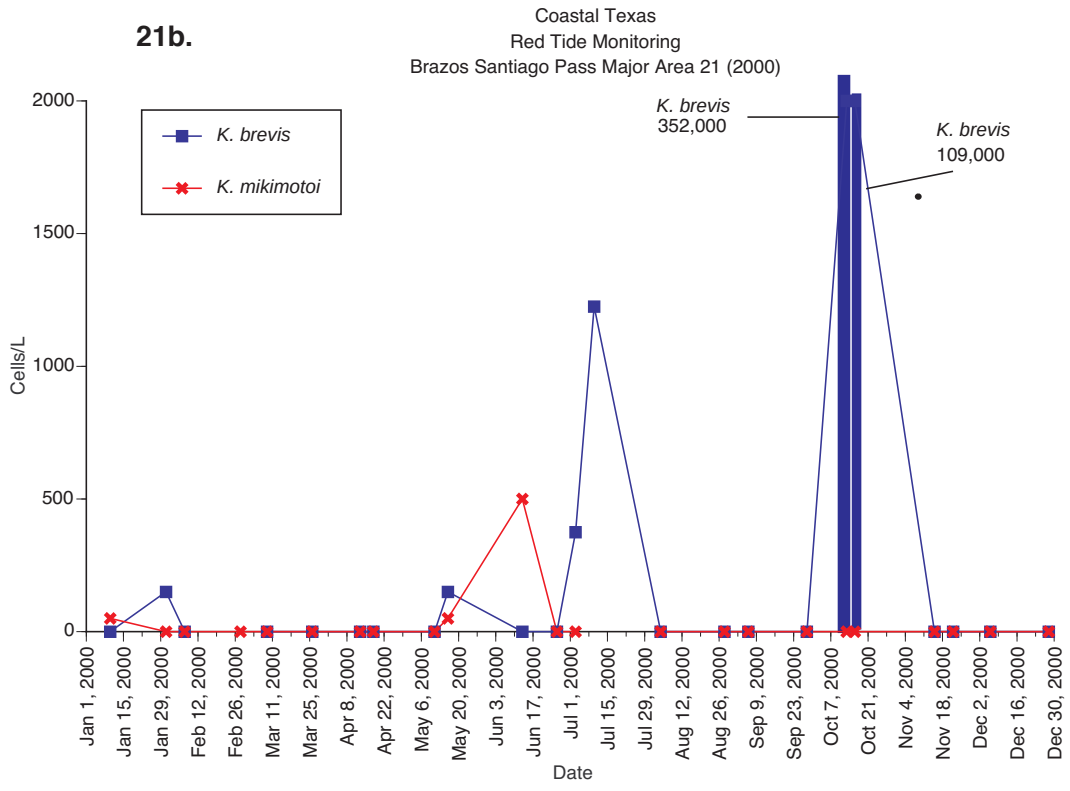

Coastal Texas
Red Tide Monitoring
Port Aransas Pass Major Area 20 (2001)
K. brevis
K. mikimotoi
Cells/L
2000
1500
1000
500
0
Dec 29, 2000
Jan 5, 2001
Jan 12, 2001
Jan 19, 2001
Jan 26, 2001
Feb 2, 2001
Feb 9, 2001
Feb 16, 2001
Feb 23, 2001
Mar 2, 2001
Mar 9, 2001
Mar 16, 2001
Mar 23, 2001
Mar 30, 2001
Apr 6, 2001
Apr 13, 2001
Date

Figure 21. Cell count data for *K. brevis* and *K. mikimotoi* at Brazos Santiago Pass. Fig. 21a. 1998-1999. Fig. 121b. 2000. Fig. 21c. 2001.



**21c.**

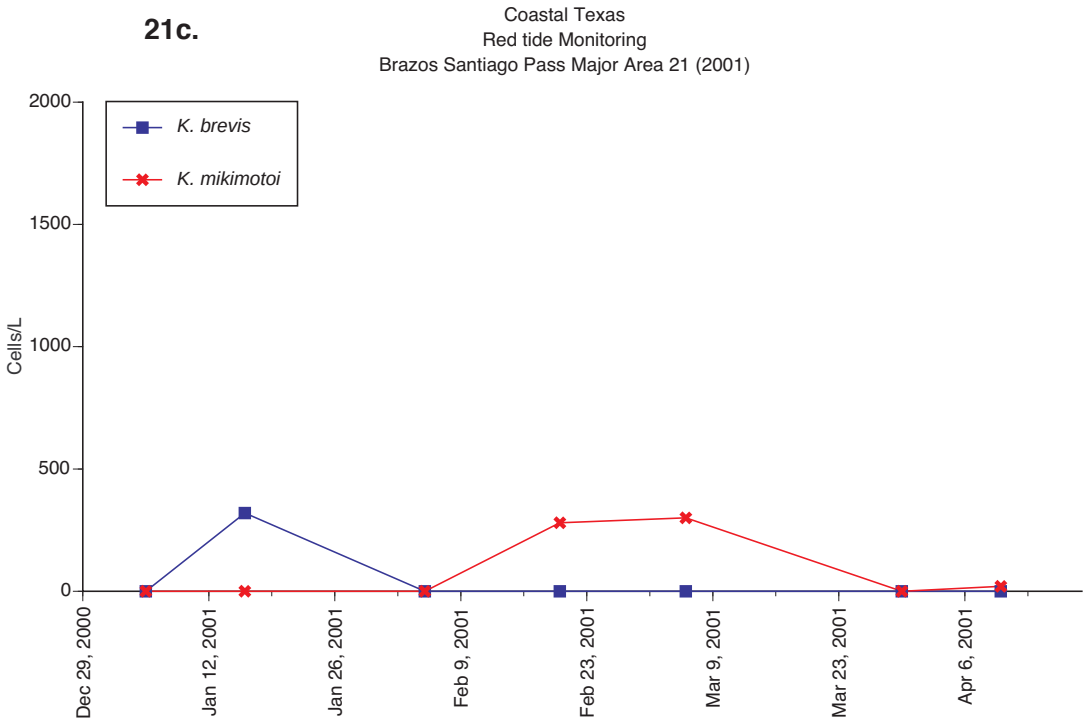

Coastal Texas
Red tide Monitoring
Brazos Santiago Pass Major Area 21 (2001)
K. brevis
K. mikimotoi
Cells/L
2000
1500
1000
500
0
Dec 29, 2000
Jan 12, 2001
Jan 26, 2001
Feb 9, 2001
Feb 23, 2001
Mar 9, 2001
Mar 23, 2001
Apr 6, 2001

Fig. 22. Chlorophyll concentration and *Karenia* cell counts. Data is from all years, all stations.

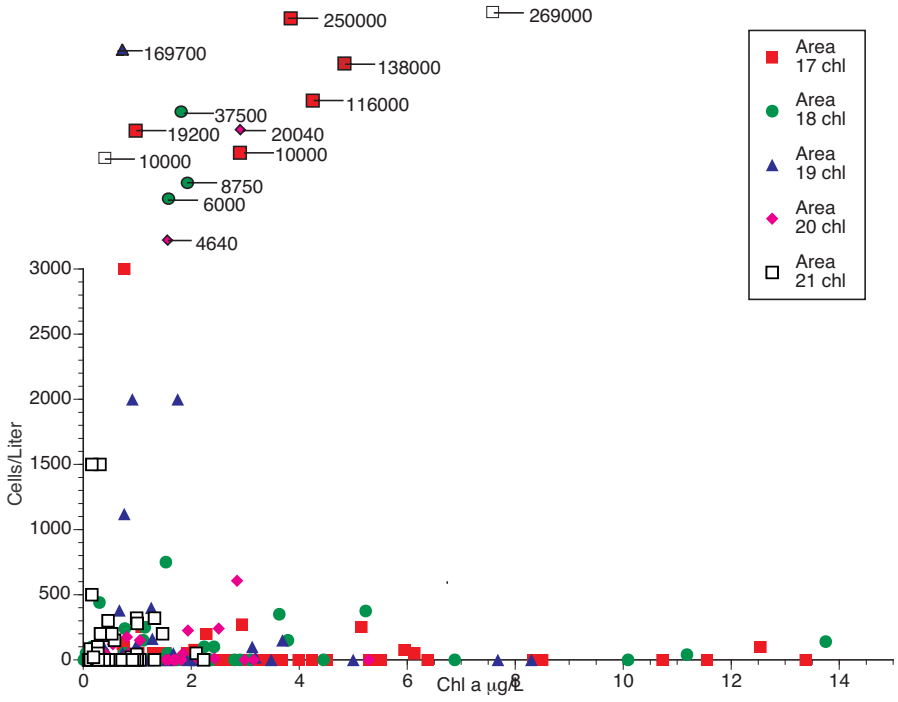


Fig. 23. *Karenia brevis* occurrence as a function of temperature and salinity. Filled squares are positive occurrence of *K. brevis*., Open circles are all data.

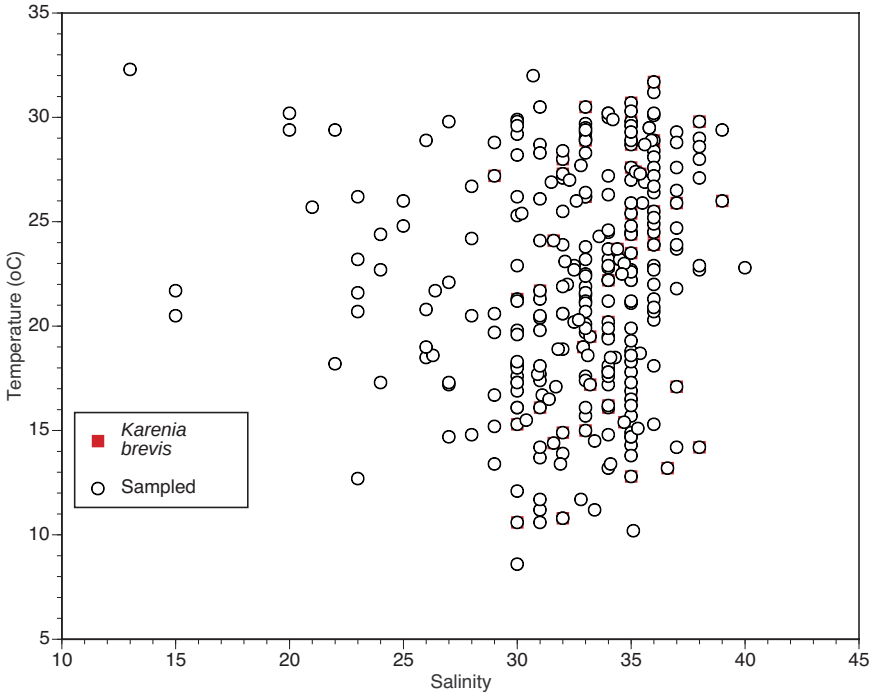
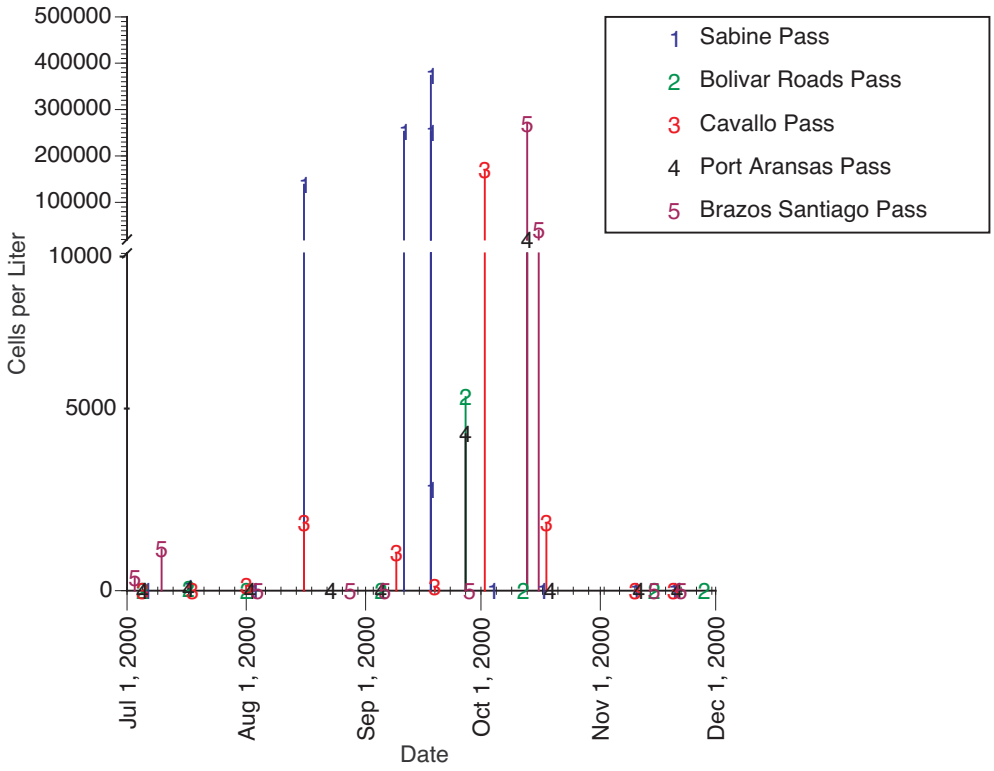


Fig. 24. Generalized time line of *K. brevis* occurrence in 2000. Note the break in the scale. Numbers corresponds to major areas and are given in the figure legend.



Appendix 1. Grid details at individual major areas.

Fig. 1. Sabine Pass

Fig. 2. Bolivar Roads

Fig. 3. Cavallo Pass

Fig. 4. Port Aransas Pass

Fig. 5. Brazos Santiago Pass

# Sabine Pass

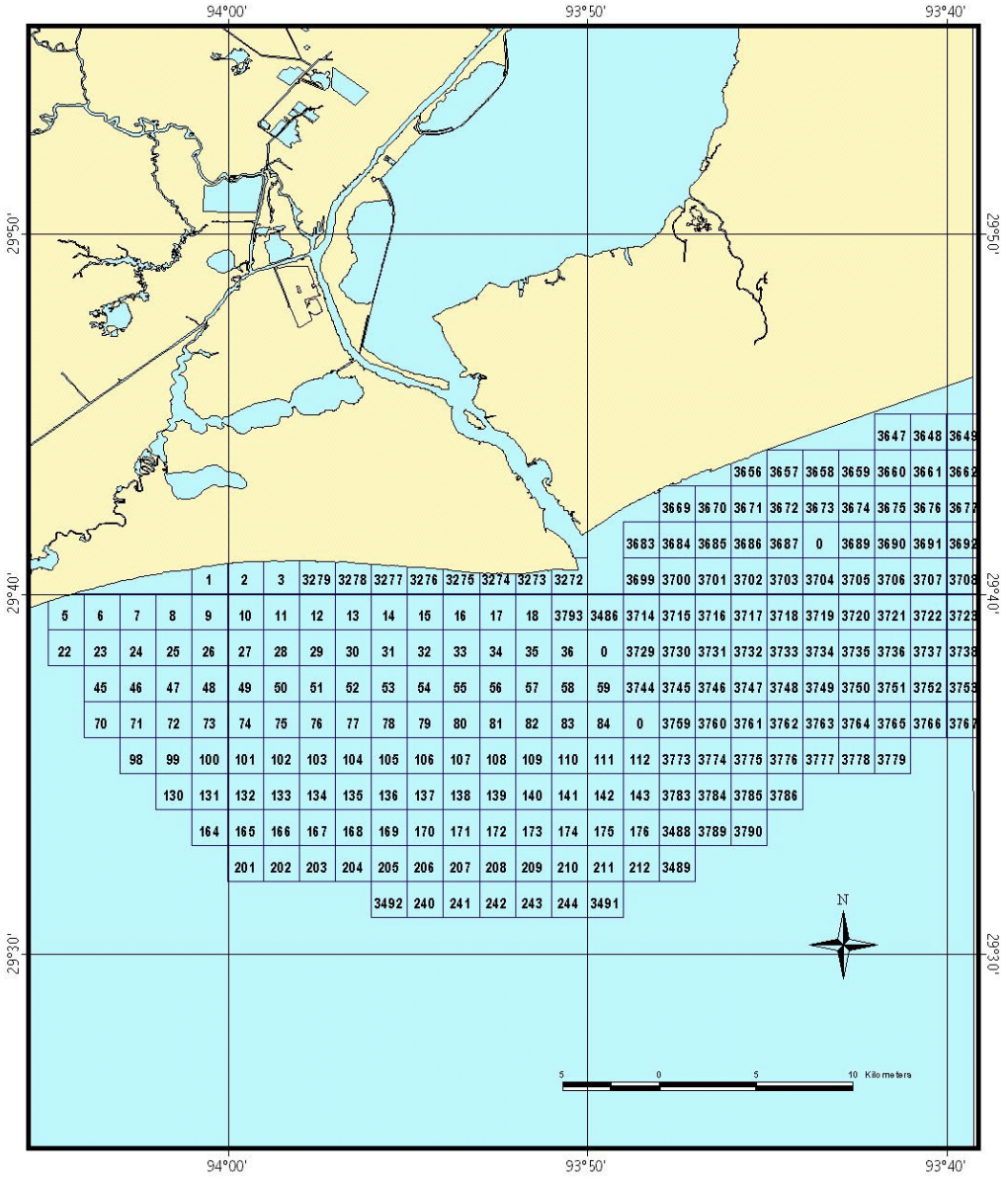



Fig. 1. Sabine Pass sampling grids

# Bolivar Roads Pass

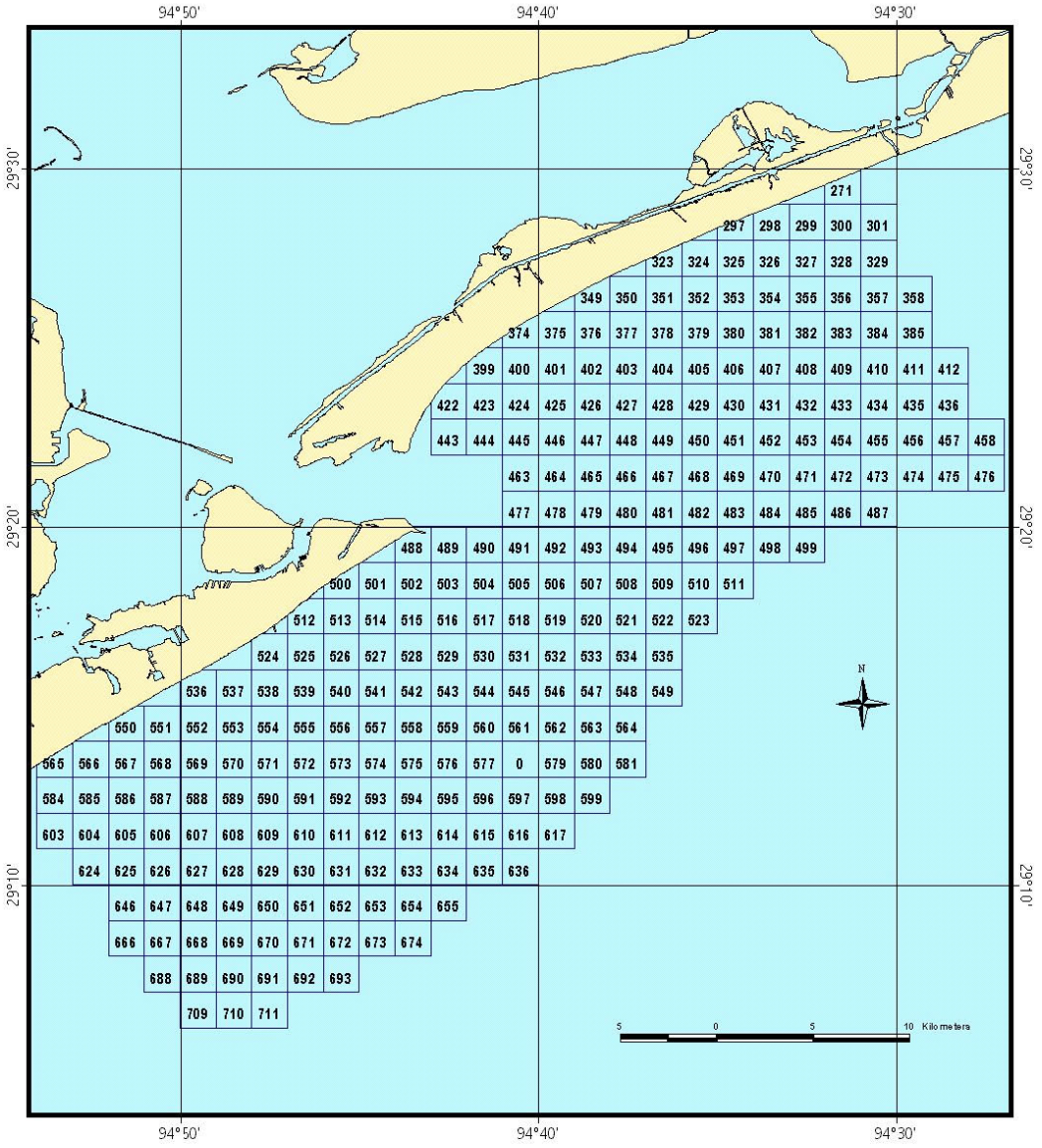



Fig. 2. Bolivar Roads Pass

# Cavallo Pass

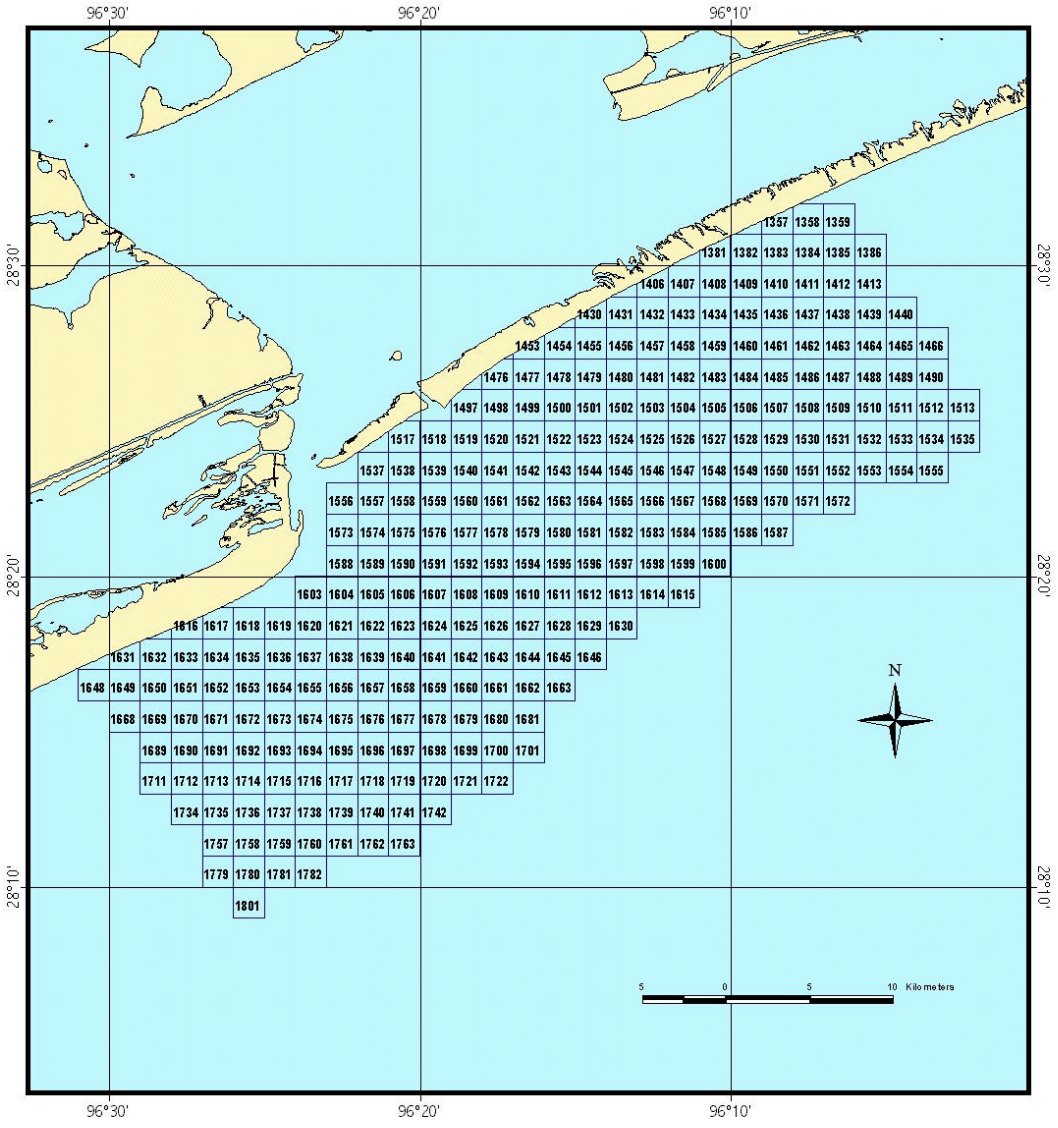



Fig. 3. Cavallo Pass

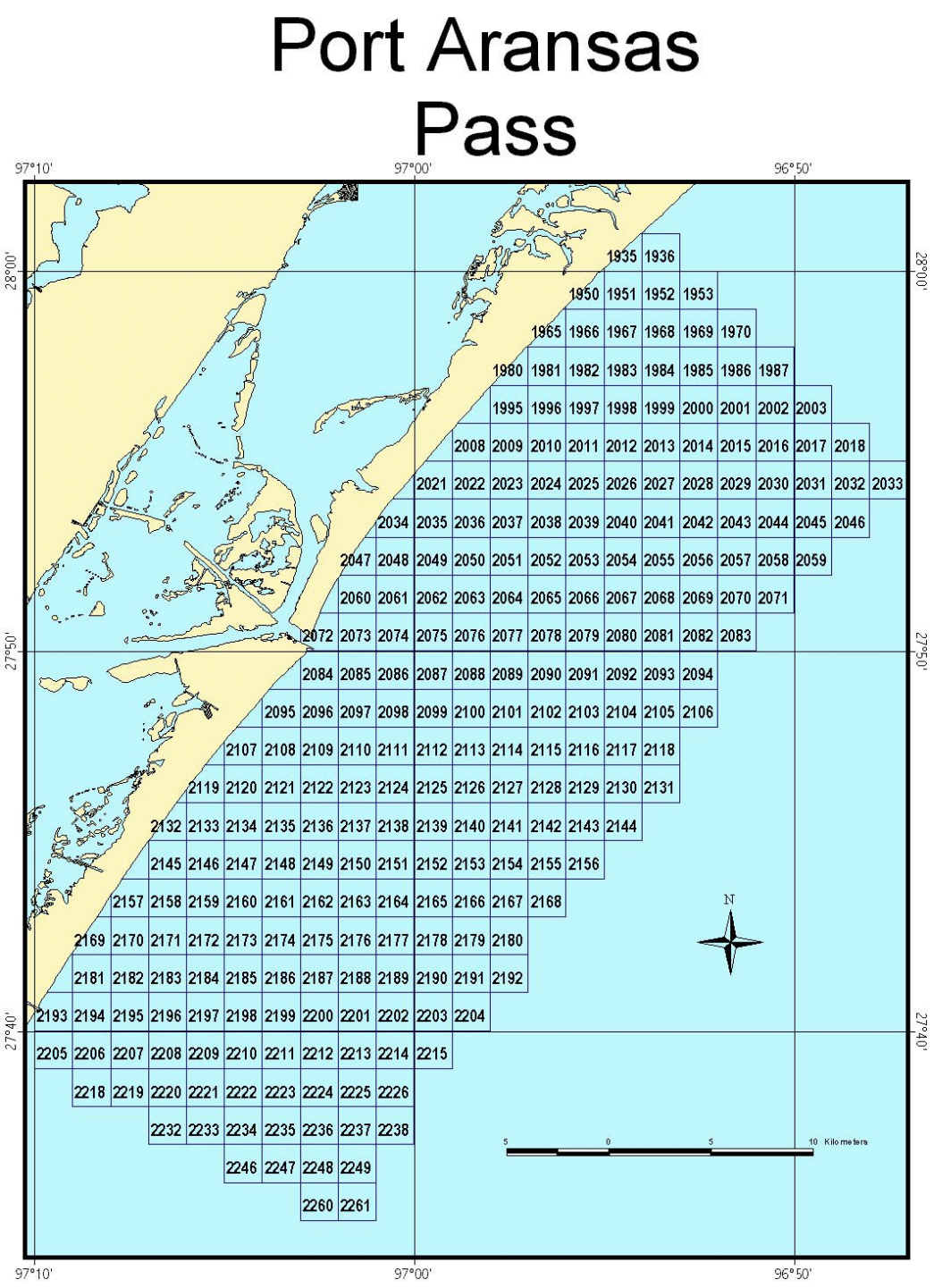



Fig. 4. Port Aransas Pass

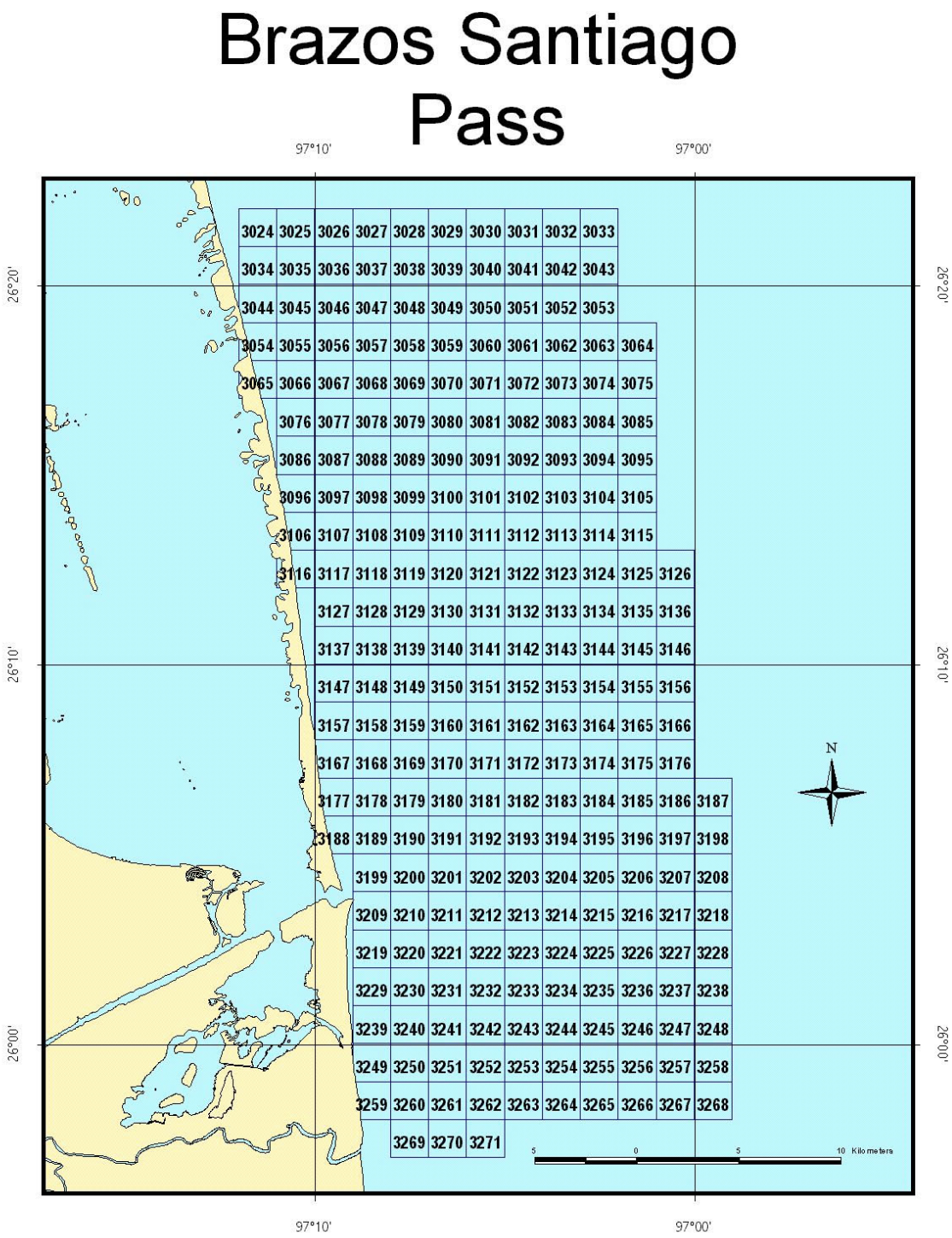



Fig. 5. Brazos Santiago Pass

## Appendix 2. Station locations, grid numbers, latitude, longitude, temperature, dissolved oxygen and salinity data for Areas 17-21.

Table 1. Hydrographic data from Area 17, Sabine Pass

Table 2. Hydrographic data from Area 18, Bolivar Roads Pass

Table 3. Hydrographic data from Area 19, Cavallo Pass

Table 4. Hydrographic data from Area 20, Port Aransas Pass

Table 5. Hydrographic data from Area 21, Brazos Santiago Pass

Station postions are given as latitude, decimal minutes and Longitude decimal minutes. The exact format is copied from the data sheets provided by TPWD and may be expressed as XX-YY-ZZZ or as XX-YY.ZZZ (=XX° YY.ZZZ')

Table 1. Hydrographic data from Area 17, Sabine Pass.

| Date | Grid | Latitude | Longitude | Temp (°C) | DO (ppm) | Salinity (ppt) |
|---|---|---|---|---|---|---|
| 11/3/98 | 212 | 29-32-30 | 93-48-28 | 21.1 | 6.7 | 35 |
| 11/16/98 | 3779 | 29-35-30 | 93-41-09 | 19.8 | 7 | 31 |
| 12/2/98 | 205 | 29-32-30 | 93-55-40 | 21.3 | 6.4 | 31 |
| 12/16/98 | 3778 | 29-35-29 | 93-42-15 | 17.9 | 6.3 | 34 |
| 1/11/99 | 201 | 29-32-27 | 93-59-48 | 13.9 | 8.3 | 32 |
| 1/19/99 | 3743 | 29-38-33 | 93-34-45 | 16.1 | 10 | 30 |
| 2/1/99 | 3778 | 29-35-31 | 93-42-15 | 17.3 | 8.6 | 24 |
| 2/18/99 | 3489 | 29-32-32 | 93-47-20 | 17.6 | 6.2 | 30 |
| 3/9/99 | 3491 | 29-31-24 | 93-49-20 | 18.2 | 7.1 | 30 |
| 3/22/99 | 240 | 29-31-32 | 93-54-51 | 18.5 | 8.5 | 26 |
| 4/6/99 | 174 | 29-33-17 | 93-50-53 | 21.7 | 7.6 | 15 |
| 4/27/99 | 212 | 29-32-28 | 93-48-27 | 24.2 | 6.7 | 28 |
| 5/7/99 | 3754 | 29-37-33 | 93-38-54 | 24.4 | 8.4 | 24 |
| 5/19/99 | 3790 | 29-33-14 | 93-45-53 | 26.2 | 8.1 | 23 |
| 6/7/99 | 243 | 29-41-27 | 93-51-48 | 30.2 | 8.2 | 20 |
| 6/16/99 | 3778 | 29-35-32 | 93-42-23 | 29.4 | 7.3 | 22 |
| 7/6/99 | 167 | 29-33-33 | 93-57-48 | 32.3 | 9.4 | 13 |
| 7/16/99 | 3790 | 29-33-07 | 93-45-08 | 29.4 | 6.6 | 20 |
| 8/2/99 | 138 | 29-34-33 | 93-53-09 | 29.9 | 4.8 | 30 |
| 8/17/99 | 3488 | 29-33-40 | 93-47-26 | 30 | 6.2 | 34 |
| 9/7/99 | 101 | 29-35-27 | 93-59-34 | 31.2 | 10.8 | 36 |
| 9/28/99 | 3764 | 29-36-16 | 93-42-30 | 26.1 | 5.6 | 31 |
| 10/11/99 | 3491 | 29-31-27 | 93-49-39 | 25.3 | 7 | 30 |
| 10/25/99 | 3767 | 29-36-32 | 93-39-21 | 21.3 | 7.2 | 30 |
| 11/1/99 | 105 | 29-35-31 | 93-55-12 | 21.5 | 7 | 33 |
| 11/17/99 | 3772 | 29-36-35 | 93-34-40 | 20.2 | 6.9 | 34 |
| 12/7/99 | 204 | 29-32-31 | 93-56-23 | 17.7 | 7.8 | 31 |
| 12/16/99 | 211 | 29-32-31 | 93-49-56 | 15.7 | 8.3 | 33 |
| 1/11/00 | 3492 | 29-31-40 | 93-55-33 | 14.3 | 7.1 | 35 |
| 1/17/00 | 3790 | 29-33-30 | 93-45-08 | 16.1 | 7.6 | 31 |
| 2/9/00 | 131 | 29-34-27 | 94-00-27 | 13.8 | 8.6 | 35 |
| 2/16/00 | 211 | 29-32-32 | 93-49-14 | 15.7 | 5.8 | 35 |
| 3/9/00 | 3492 | 29-31-32 | 93-55-27 | 20.6 | 6.4 | 32 |
| 3/20/00 | 3753 | 29-37-27 | 93-39-31 | 19.8 | 8.8 | 30 |
| 4/5/00 | 175 | 29-33-32 | 93-49-17 | 20.5 | 6.8 | 28 |
| 4/18/00 | 3771 | 29-36-37 | 93-35-48 | 23.2 | 10.5 | 23 |
| 5/16/00 | 99 | 29-35-29 | 94-01-55 | 25.7 | 6.2 | 21 |
| 5/22/00 | 211 | 29-32-33 | 93-49-39 | 28.8 | 10.4 | 29 |
| 6/1/00 | 206 | 29-32-28 | 93-54-46 | 29.2 | 7.5 | 30 |
| 6/22/00 | 3491 | 29-32-28 | 93-54-46 | 28.9 | 7.1 | 26 |
| 7/6/00 | 210 | 29-32-25 | 93-50-36 | 32 | 7.3 | 30.7 |
| 7/17/00 | 212 | 29-32-30 | 93-48-33 | 29.8 | 5.2 | 35 |
| 8/3/00 | 172 | 29-33-22 | 93-52-46 | 30.1 | 6.2 | 36 |
| 8/16/00 | 3768 | 29-36-50 | 93-38-48 | 31.7 | 6.6 | 36 |
| 8/16/00 | 3731 | 29-38-30 | 93-46-23 | 30.7 | 6.3 | 35 |
| 9/11/00 | 3766 | 29-36-32 | 93-40-50 | 28.7 | 3.1 | 35 |

| Date | Grid | Latitude | Longitude | Temp (°C) | DO (ppm) | Salinity (ppt) |
|---|---|---|---|---|---|---|
| 9/11/00 | 3783 | 29-34-30 | 93-47-12 | 28.9 | 5.6 | 36 |
| 9/18/00 | 77 | 29-36-28 | 93-56-50 | 27.2 | 6 | 29 |
| 9/18/00 | 175 | 29-33-27 | 93-49-29 | 27.6 | 7.1 | 35 |
| 9/18/00 | N/A | 29-32-56.7 | 93-46-17.8 | 27.9 | 6.4 | 0 |
| 10/4/00 | 3491 | 29-31-27 | 93-49-17 | 26.3 | 5.9 | 34 |
| 10/17/00 | 3779 | 29-35-30 | 93-41-17 | 21.9 | 6 | 33 |
| 11/10/00 | 107 | 29-35-34 | 93-53-53 | 20.4 | 7 | 31 |
| 11/20/00 | 3786 | 29-34-25 | 93-44-42 | 17.1 | 7.7 | 37 |
| 12/6/00 | 211 | 29-32-27 | 93-49-20 | 14.9 | 7.9 | 32 |
| 12/29/00 | 3768 | 29-36-20 | 93-38-33 | 11.2 | 8.7 | 31 |
| 1/4/01 | 205 | 29-32-26 | 93-55-41 | 8.6 | 10 | 30 |
| 1/23/01 | 3488 | 29-33-30 | 93-47-12 | 10.6 | 8.5 | 31 |
| 2/5/01 | 134 | 29-34-40 | 93-57-24 | 12.7 | 9.8 | 23 |
| 2/19/01 | 3760 | 29-36-30 | 93-46-52 | 14.7 | 8 | 27 |
| 3/5/01 | 243 | 29-31-36 | 93-51-47 | 18.2 | 7.1 | 22 |
| 3/21/01 | 3740 | 29-38-31 | 93-37-20 | 17.2 | 8.1 | 27 |
| 4/4/01 | 243 | 29-31-30 | 93-51-45 | 20.5 | 10.5 | 15 |

Table 2. Hydrographic data from Area 18, Bolivar Roads Pass

| Date | Grid | Latitude | Longitude | Temp (°C) | DO (ppm) | Salinity (ppt) |
|---|---|---|---|---|---|---|
| 11/3/98 | 486 | 29-20-52 | 94-31-41 | 23.2 | 6.7 | 34 |
| 11/16/98 | 635 | 29-10-38 | 94-41-41 | 20.3 | 7.1 | 36 |
| 12/1/98 | 483 | 29-20-55 | 94-34-12 | 21.2 | 5.7 | 30 |
| 12/16/98 | 711 | 29-06-28 | 94-47-44 | 16.1 | 7.8 | 30 |
| 1/11/99 | 475 | 29-21-27 | 94-28-49 | 13.4 | 7.7 | 29 |
| 1/19/99 | 652 | 29-09-21 | 94-45-05 | 14.8 | 8.3 | 28 |
| 2/17/99 | 671 | 29-08-48 | 94-46-26 | 17.3 | 6.8 | 30 |
| 3/10/99 | 606 | 29-11-05 | 94-50-25 | 19.7 | 7.8 | 29 |
| 3/16/99 | 433 | 29-23-32 | 94-31-21 | 17.6 | 6.9 | 33 |
| 4/6/99 | 671 | 29-08-02 | 94-46-53 | 21.6 | 7 | 23 |
| 4/27/99 | 458 | 29-22-00 | 94-27-47 | 23.9 | 7.4 | 32 |
| 5/13/99 | 474 | 29-21-04 | 94-29-48 | 24.8 | 6.2 | 25 |
| 5/22/99 | 711 | 29-06-42 | 94-47-39 | 26.2 | 6.6 | 33 |
| 5/25/99 | 615 | 29-11-12 | 94-41-20 | 27.2 | 5.4 | 34 |
| 6/10/99 | 474 | 29-21-11 | 94-29-30 | 28.7 | 6.3 | 31 |
| 7/8/99 | 458 | 29-22-25 | 94-27-38 | 29.8 | 6.8 | 27 |
| 7/27/99 | 636 | 29-10-02 | 94-40-57 | 30.5 | 9.5 | 31 |
| 8/3/99 | 485 | 29-20-30 | 94-32-30 | 30.3 | 7.3 | 35 |
| 8/16/99 | 693 | 29-07-30 | 94-45-30 | 29.4 | 5.9 | 39 |
| 9/7/99 | 668 | 29-08-55 | 94-49-12 | 30.2 | 6 | 34 |
| 9/20/99 | 563 | 29-14-45 | 94-38-41 | 28.4 | 6.3 | 36 |
| 10/13/99 | 473 | 29-21-58 | 94-30-45 | 25.4 | 6.6 | 30.2 |
| 10/25/99 | 688 | 29-07-24 | 94-50-27 | 22.8 | 6.1 | 40 |
| 11/4/99 | 411 | 29-24-47 | 94-29-28 | 20.7 | 5.9 | 36 |
| 12/1/99 | 624 | 29-10-10 | 94-52-29 | 18.9 | 7.3 | 32 |
| 12/14/99 | 474 | 29-21-23 | 94-29-53 | 17.4 | 5.5 | 31 |
| 12/16/99 | 692 | 29-07-59 | 94-46-42 | 17.2 | 6.1 | 34 |
| 1/11/00 | 408 | 29-24-31 | 94-32-23 | 14.7 | 7.4 | 35 |
| 1/25/00 | 650 | 29-09-55 | 94-47-12 | 15.3 | 8 | 30 |
| 2/8/00 | 471 | 29-21-29 | 94-32-30 | 12.8 | 6.2 | 35 |
| 3/1/00 | 648 | 29-09-39 | 94-49-55 | 17.8 | 7.6 | 35 |
| 3/13/00 | 457 | 29-22-30 | 94-28-38 | 19.6 | 8.1 | 30 |
| 3/24/00 | 674 | 29-08-32 | 94-43-40 | 21.3 | 6.8 | 36 |
| 4/5/00 | 542 | 29-15-58 | 94-43-25 | 21.6 | 5.8 | 33 |
| 4/19/00 | 636 | 29-10-32 | 94-40-35 | 22.2 | 8.6 | 34 |
| 5/11/00 | 385 | 29-25-32 | 94-29-31 | 26 | 7.4 | 25 |
| 5/22/00 | 711 | 29-06-42 | 94-47-39 | 26.2 | 6.6 | 33 |
| 6/13/00 | 436 | 29-23-33 | 94-28-29 | 28.3 | 5.2 | 31 |
| 7/5/00 | 458 | 29-22-15 | 94-27-20 | 29.6 | 5.8 | 35 |
| 7/17/00 | 692 | 29-07-59 | 94-46-13 | 28.9 | 9.6 | 35 |
| 8/1/00 | 384 | 29-25-26 | 94-30-44 | 29 | 2.9 | 38 |
| 8/21/00 | 693 | 29-07-39 | 94-45-19 | 29.8 | 6.8 | 38 |
| 9/5/00 | 670 | 29-08-35 | 94-47-44 | 30.2 | 6 | 36 |
| 9/27/00 | 468 | 29-21-03 | 94-35-54 | 26 | 5.9 | 39 |
| 10/12/00 | 411 | 29-24-09 | 94-29-41 | 20.6 | 7.2 | 29 |
| 10/16/00 | 649 | 29-09-29 | 94-48-19 | 21.7 | 5.3 | 31 |

| Date | Grid | Latitude | Longitude | Temp (°C) | DO (ppm) | Salinity (ppt) |
|---|---|---|---|---|---|---|
| 11/15/00 | 328 | 29-27-02 | 94-31-47 | 16.9 | 7.2 | 30 |
| 11/27/00 | 692 | 29-07-44 | 94-46-51 | 18.1 | 6.6 | 34 |
| 12/7/00 | 487 | 29-20-35 | 94-30-55 | 14.2 | 8.1 | 38 |
| 12/29/00 | 674 | 29-08-39 | 94-43-49 | 11.7 | 8.1 | 31 |
| 1/15/01 | 692 | 29-07-54 | 94-46-08 | 10.2 | 7.3 | 35.1 |
| 1/22/01 | 533 | 29-16-39 | 94-38-46 | 10.6 | 8.4 | 30 |
| 2/5/01 | 329 | 29-27-29 | 94-30-45 | 12.1 | 8 | 30 |
| 2/20/01 | 691 | 29-07-01 | 94-47-66 | 15.5 | 5.7 | 30.4 |
| 3/5/01 | 692 | 29-07-47 | 94-46-39 | 17.6 | 6.8 | 34 |
| 3/30/01 | 435 | 29-23-35 | 94-29-30 | 16.7 | 7.1 | 31.1 |
| 4/2/01 | 521 | 29-17-08 | 94-37-01 | 18.6 | 8.8 | 26.3 |

Table 3. Hydrographic data from Area 19, Cavallo Pass

| Date | Grid | Latitude | Longitude | Temp (°C) | DO (ppm) | Salinity (ppt) |
|---|---|---|---|---|---|---|
| 11/2/98 | 1586 | 29-21-25 | 96-09-35 | 24.5 | 6.6 | 35 |
| 11/16/98 | 1721 | 28-13-25 | 96-18-30 | 21.2 | 6.2 | 33 |
| 12/1/98 | 1587 | 28-21-28 | 96-08-33 | 22 | 5.8 | 36 |
| 12/16/98 | 1721 | 28-13-30 | 96-18-90 | 18.1 | 6.8 | 30 |
| 1/5/99 | 1554 | 28-23-28 | 96-04-33 | 14.9 | 7.4 | 35 |
| 1/18/99 | 1721 | 28-13-27 | 96-18-33 | 14.7 | 7.6 | 35 |
| 2/1/99 | 1512 | 28-25-29 | 96-03-43 | 16.1 | 6.6 | 33 |
| 2/18/99 | 1630 | 28-18-50 | 96-12-48 | 18.2 | 7.8 | 30 |
| 3/9/99 | 1585 | 28-21-34 | 96-10-40 | 19 | 7.1 | 26 |
| 3/16/99 | 1700 | 28-14-33 | 96-17-13 | 18 | 7.7 | 30 |
| 4/6/99 | 1599 | 28-20-02 | 96-12-26 | 20.7 | 7.8 | 23 |
| 4/19/99 | 1719 | 28-13-30 | 96-20-30 | 22.1 | 7.3 | 27 |
| 5/5/99 | 1553 | 28-23-10 | 96-06-07 | 24.1 | 6.7 | 31 |
| 5/19/99 | 1701 | 28-13-57 | 96-17-03 | 25.5 | 6.8 | 32 |
| 6/1/99 | 1570 | 28-22-35 | 96-08-26 | 27.1 | 6.4 | 32 |
| 6/16/99 | 1761 | 28-11-25 | 96-22-37 | 29.7 | 5.5 | 33 |
| 7/6/99 | 1535 | 28-23-53 | 96-03-35 | 29.8 | 5.7 | 30 |
| 7/20/99 | 1715 | 28-13-30 | 96-24-30 | 29.6 | 4.9 | 30 |
| 8/2/99 | 1681 | 28-15-30 | 96-16-30 | 29.3 | 5.4 | 37 |
| 8/16/99 | 1760 | 28-11-30 | 96-23-30 | 28.6 | 5.5 | 38 |
| 9/1/99 | 1582 | 28-21-32 | 96-13-35 | 30.2 | 6 | 34 |
| 9/20/99 | 1719 | 28-13-38 | 96-20-01 | 29.5 | 5.2 | 33 |
| 10/2/99 | 1554 | 28-23-55 | 96-04-12 | 27 | 6 | 35 |
| 10/21/99 | 1614 | 28-19-21 | 96-12-36 | 24.5 | 5.8 | 34 |
| 11/1/99 | 1572 | 28-22-06 | 96-06-47 | 23.7 | 4.5 | 34 |
| 11/16/99 | 1759 | 28-11-24 | 96-24-31 | 22.5 | 6.3 | 33 |
| 12/6/99 | 1596 | 28-20-46 | 96-14-05 | 19.5 | 6.9 | 34 |
| 12/16/99 | 1736 | 28-13-06 | 96-25-06 | 18.8 | 7 | 35 |
| 1/6/00 | 1582 | 28-21-30 | 96-13-34 | 16.9 | 7.7 | 35 |
| 1/17/00 | 1676 | 28-15-14 | 96-21-52 | 17.8 | 7.8 | 34 |
| 2/6/00 | 1508 | 28-25-41 | 96-07-30 | 13.2 | 8.1 | 34 |
| 2/16/00 | 1698 | 28-14-25 | 96-19-29 | 17.4 | 8.3 | 33 |
| 3/8/00 | 1572 | 28-22-30 | 96-06-30 | 20.1 | 7.2 | 33 |
| 3/27/00 | 1714 | 28-13-30 | 96-25-30 | 21.1 | 6.7 | 33 |
| 4/13/00 | 1466 | 28-27-09 | 96-04-18 | 21.2 | 6.1 | 34 |
| 4/16/00 | 1760 | 28-11-42 | 96-23-24 | 22.2 | 6.2 | 34 |
| 5/16/00 | 1615 | 28-19-30 | 96-11-30 | 26.4 | 7.6 | 33 |
| 5/21/00 | 1717 | 28-13-474 | 96-22-488 | 26.7 | 6.1 | 28 |
| 6/13/00 | 1534 | 28-24-672 | 96-04-041 | 28.2 | 5.8 | 30 |
| 6/27/00 | 1801 | 28-09-980 | 96-25-120 | 28.9 | 6 | 33 |
| 7/5/00 | 1583 | 28-21-329 | 96-13-054 | 29 | 5.9 | 33 |
| 7/18/00 | 1782 | 28-10-518 | 96-23-487 | 27.3 | 5.9 | 32 |
| 8/1/00 | 1552 | 28-23- | 96-06- | 28 | 5.7 | 32 |
| 8/16/00 | 1659 | 28-16-32 | 96-19-40 | 30.5 | 5.3 | 33 |
| 9/9/00 | 1535 | 28-24-341 | 96-02-834 | 29.3 | 5.6 | 33 |
| 9/19/00 | 1801 | 28-09-52 | 96-25-09 | 28.9 | 6 | 33 |

| Date | Grid | Latitude | Longitude | Temp (°C) | DO (ppm) | Salinity (ppt) |
|---|---|---|---|---|---|---|
| 10/2/00 | 1554 | 28-23- | 96-04- | 27.3 | 6.2 | 32 |
| 10/18/00 | 1762 | 28-11-30 | 96-21-31 | 24.5 | 6.3 | 36 |
| 11/10/00 | 1569 | 28-22-31 | 96-09-24 | 22.4 | 6.2 | 33 |
| 11/20/00 | 1693 | 28-14-30 | 96-24-27 | 17.3 | 7.7 | 27 |
| 12/5/00 | 1586 | 28-21-33 | 96-09-37 | 16.5 | 7.4 | 35 |
| 12/19/00 | 1720 | 28-13-42 | 96-19-20 | 15 | 8.8 | 33 |
| 12/19/00 | 1720 | 28-13-42 | 96-19-20 | 15 | 8.8 | 33 |
| 1/4/01 | 1701 | 28-14-32 | 96-16-35 | 10.8 | 9.3 | 32 |
| 1/22/01 | 1587 | 28-21-313 | 96-08-703 | 10.8 | 9.4 | 32 |
| 2/12/01 | 1758 | 28-11-21 | 96-25-40 | 13.7 | 8.5 | 31 |
| 2/20/01 | 1585 | 28-21-29 | 96-10-39 | 15.2 | 8.1 | 29 |
| 3/5/01 | 1570 | 28-22-24 | 96-08-30 | 16.7 | 8.3 | 29 |
| 3/21/01 | 1646 | 28-17- | 96-14- | 18.3 | 7.2 | 30 |
| 4/10/01 | 1587 | 28-21-500 | 96-08-500 | 22.7 | 8.6 | 24 |

Table 4. Hydrographic data from Area 20, Port Aransas Pass

| Date | Grid | Latitude | Longitude | Temp (°C) | DO (ppm) | Salinity (ppt) |
|---|---|---|---|---|---|---|
| 11/15/98 | 2118 | 27-47-48 | 96-53-44 | 21.2 | 6.5 | 35 |
| 11/16/98 | 2238 | 27-37-32 | 97-00-20 | 22.2 | 6.1 | 35 |
| 12/1/98 | 2131 | 27-46-30 | 96-53-30 | 22.2 | 7.9 | 34 |
| 12/16/98 | 2226 | 27-38-584 | 97-00-496 | 19.7 | 7.1 | 33 |
| 1/5/99 | 2081 | 27-50-35 | 96-53-55 | 14.2 | 6.8 | 31 |
| 1/16/99 | 2190 | 27-41-54 | 96-59-50 | 14.2 | 7.6 | 37 |
| 2/14/99 | 2249 | 27-36-61 | 97-01-42 | 17.3 | 7.8 | 30 |
| 2/18/99 | 2130 | 27-46-45 | 96-54-54 | 17.8 | 9.7 | 34 |
| 3/24/99 | 2118 | 27-47-35 | 96-54-05 | 20.5 | 8 | 31 |
| 4/6/99 | 2154 | 27-44-57 | 96-57-56 | 20.8 | 11.3 | 26 |
| 4/27/99 | 2247 | 27-36.370 | 96-03.630 | 22.9 | 7.7 | 30 |
| 5/5/99 | 2248 | 27-36.487 | 97-02.647 | 23.8 | 6.9 | 33 |
| 5/19/99 | 2032 | 27-54.476 | 96-48.637 | 26.2 | 6.6 | 30 |
| 6/8/99 | 2202 | 27-41-168 | 97-00-556 | 28.3 | 6.6 | 33 |
| 6/16/99 | 2094 | 27-49-26 | 96-52-39 | 29.4 | 5.9 | 33 |
| 7/6/99 | 2117 | 27-47-405 | 96-54-551 | 28.4 | 6.6 | 32 |
| 7/28/99 | 2226 | 27-38-727 | 97-00-322 | 29.9 | 5.9 | 34.2 |
| 8/4/99 | 2070 | 27-51-57 | 96-50-00 | 29.5 | 5.3 | 35.8 |
| 8/17/99 | 2238 | 27-37-547 | 97-00-461 | 28.1 | 1 | 36 |
| 9/9/99 | 2031 | 27-55-10 | 96-49-17 | 29.5 | 6.1 | 35.8 |
| 9/20/99 | 2214 | 27-39-568 | 97-00-405 | 29.3 | 5.6 | 35 |
| 10/11/99 | 2127 | 27-46-607 | 96-57-450 | 26.9 | 5.4 | 31.5 |
| 10/22/99 | 2203 | 27-40-27 | 96-59-20 | 24.1 | 5.2 | 31.6 |
| 11/8/99 | 2070 | 27-51-472 | 96-51-562 | 23.2 | 8.4 | 33 |
| 11/23/99 | 2247 | 27-36.579 | 97-03.532 | 24.3 | 8.8 | 33.6 |
| 12/7/99 | 2068 | 27-51.67 | 96-53.34 | 20.2 | 7.4 | 32.5 |
| 12/17/99 | 2190 | 27-41-30 | 96-59-17 | 19 | 7.3 | 32.9 |
| 1/6/00 | 2032 | 27-54.660 | 96-48.414 | 18.5 | 10.5 | 34.3 |
| 1/17/00 | 2190 | 27-41-30 | 96-59-17 | 19 | 7.3 | 32.9 |
| 1/25/00 | 2144 | 27-45-30 | 96-54-30 | 18.6 | 0 | 33.1 |
| 2/8/00 | 2202 | 27-40.642 | 97-00.200 | 14.4 | 8 | 31.6 |
| 2/22/00 | 2058 | 27-52.853 | 97-50.720 | 17.1 | 7.8 | 31.7 |
| 3/1/00 | 2130 | 27-47.099 | 97-54.787 | 18.9 | 6.8 | 31.8 |
| 3/24/00 | 2118 | 27-47-01 | 96-54-04 | 20.7 | 7.5 | 33 |
| 4/13/00 | 2083 | 27-50-33 | 96-51-92 | 22 | 6.3 | 32.2 |
| 4/17/00 | 2188 | 27-41-51 | 97-01-17 | 22.9 | 6.3 | 32.5 |
| 5/10/00 | 2237 | 27-37-51 | 97-01-97 | 26 | 7.7 | 32.6 |
| 5/21/00 | 2046 | 27-53.05 | 96-48.82 | 27 | 7 | 32.3 |
| 6/6/00 | 2070 | 27-51.353 | 96-51.695 | 26.9 | 11.2 | 35.6 |
| 6/27/00 | 2131 | 27-46.58 | 96-53.47 | 28.9 | 6 | 35.9 |
| 7/5/00 | 2055 | 27-52-558 | 96-53-157 | 0 | 6 | 33.4 |
| 7/17/00 | 2155 | 27-44.929 | 96-56.432 | 25.5 | 1.3 | 36 |
| 8/2/00 | 2192 | 27-41.072 | 96-58.220 | 27.7 | 6.2 | 32.8 |
| 8/23/00 | 2102 | 27-48-40 | 96-56-46 | 28.7 | 6.3 | 35.6 |
| 9/5/00 | 2180 | 27-42- | 96-57- | 25.9 | 6.3 | 35.5 |
| 9/27/00 | 2045 | 27-53-662 | 96-49-872 | 27.4 | 5.6 | 35.2 |

| Date | Grid | Latitude | Longitude | Temp (°C) | DO (ppm) | Salinity (ppt) |
|---|---|---|---|---|---|---|
| 10/13/00 | 2033 | 27-54-25 | 96-47-53 | 23.2 | 6.6 | 34.5 |
| 10/19/00 | 2226 | 27-38-13 | 97-00-59 | 23.1 | 6.1 | 32.1 |
| 11/11/00 | 2179 | 27-42-47 | 96-58-70 | 22.7 | 8.4 | 32.5 |
| 11/21/00 | 2131 | 27-46.53 | 96-53.91 | 19.5 | 9.2 | 33.2 |
| 12/5/00 | 2105 | 27-49-30 | 96-53-30 | 17.2 | 9.4 | 33.2 |
| 12/16/00 | 2236 | 27-37-30 | 97-02-30 | 16.1 | 7 | 34 |
| 1/4/01 | 2033 | 27-54-47 | 96-47-49 | 11.2 | 8.1 | 33.4 |
| 1/12/01 | 2191 | 27-41-40 | 96.58-56 | 11.7 | 8.6 | 32.8 |
| 2/12/01 | 2177 | 27-42-55 | 97-00-49 | 13.4 | 7.8 | 31.9 |
| 2/19/01 | 2116 | 24-47-43 | 96-55-49 | 14.5 | 7.4 | 33.4 |
| 3/5/01 | 2156 | 27-44- | 96-55- | 16.5 | 7 | 31.4 |
| 3/21/01 | 2212 | 27-39-43 | 97-02-44 | 17.7 | 8.1 | 30.9 |
| 4/12/01 | 2080 | 27-50.53 | 96-54.77 | 21.7 | 7.4 | 26.4 |

Table 5. Hydrographic data from Area 21, Brazos Santiago Pass

| Date | Grid | Latitude | Longitude | Temp (°C) | DO (ppm) | Salinity (ppt) |
|---|---|---|---|---|---|---|
| 11/13/98 | 3198 | 26-05-54 | 96-59-23 | 24.6 | 6.4 | 34 |
| 11/17/98 | 3136 | 26-11-46 | 97-00-32 | 22.7 | 9.8 | 35 |
| 12/2/98 | 3145 | 26-11-180 | 97-01-718 | 23.7 | 6.6 | 37 |
| 12/16/98 | 3064 | 26-18.591 | 97-01.626 | 19.9 | 9 | 35 |
| 1/15/99 | 3268 | 25-58.333 | 96-59.411 | 17.3 | 8.3 | 35 |
| 1/25/99 | 3085 | 26-16.548 | 97-01.443 | 18.3 | 10.5 | 35 |
| 2/1/99 | 3184 | 26-06-34 | 97-02-29 | 18.7 | 8.9 | 35.4 |
| 2/24/99 | 3133 | 26-11-550 | 97-03-506 | 18.6 | 8.7 | 35 |
| 3/1/99 | 3266 | 26-58-630 | 97-01-447 | 19.3 | 11.2 | 35 |
| 3/22/99 | 3114 | 26-13-47 | 97-02-35 | 20.6 | 4 | 32 |
| 4/6/99 | 3154 | 26-09-34 | 97-02-35 | 22.8 | 6.8 | 34 |
| 4/18/99 | 3085 | 26-16.697 | 97-01.698 | 21.9 | 6.6 | 32 |
| 5/13/99 | 3187 | 26-06.418 | 96-59.671 | 23.9 | 14 | 36 |
| 5/19/99 | 3136 | 26-11.446 | 97.00.562 | 25.4 | 8 | 35 |
| 6/2/99 | 3268 | 25-58-491 | 97-59-619 | 24.7 | 6.8 | 37 |
| 6/16/99 | 3063 | 26-18-505 | 97-02-496 | 27.1 | 4.4 | 38 |
| 7/6/99 | 3268 | 25-58-604 | 96-59-494 | 22.7 | 13.1 | 38 |
| 7/19/99 | 3075 | 26-17-590 | 97-01-499 | 27.6 | 7.1 | 36 |
| 8/2/99 | 3146 | 26-10-500 | 97-00-610 | 22.9 | 7.6 | 38 |
| 8/16/99 | 3124 | 26-12-30 | 97-02-34 | 27.6 | 6.3 | 37 |
| 9/1/99 | 3198 | 26-05-550 | 96-59-438 | 28.8 | 6.2 | 37 |
| 9/18/99 | 3126 | 26-12-480 | 97-00-554 | 28 | 5.7 | 38 |
| 10/11/99 | 3163 | 26-08-503 | 97-03-400 | 26.5 | 9 | 37 |
| 10/25/99 | 3074 | 26-17-410 | 97-02-547 | 23.5 | 7.4 | 35 |
| 11/8/99 | 3258 | 25-59-344 | 96-59-503 | 24.4 | 5.5 | 35 |
| 11/18/99 | 3033 | 26-21-510 | 97-02-667 | 22.9 | 10.8 | 34 |
| 12/7/99 | 3257 | 25-59-30 | 97-00-39 | 22.2 | 6.6 | 35 |
| 12/27/99 | 3145 | 26-10-29 | 97-01-25 | 18.1 | 5.7 | 36 |
| 1/10/00 | 3187 | 26-06-36 | 96-59-28 | 19.4 | 9.8 | 34 |
| 1/31/00 | 3041 | 26-20-31 | 97-04-34 | 16.2 | 9.8 | 34 |
| 2/7/00 | 3228 | 26-02.493 | 96-59.502 | 15.3 | 6.8 | 36 |
| 2/28/00 | 3042 | 26-20-41 | 97-03-36 | 19.9 | 7.8 | 33 |
| 3/9/00 | 3166 | 26-08.515 | 97-00.003 | 21.8 | 11.3 | 37 |
| 3/26/00 | 3095 | 26-15.502 | 97-01.535 | 20.9 | 8.5 | 36 |
| 4/13/00 | 3217 | 26-03.467 | 97-00.444 | 22.6 | 6.2 | 35 |
| 4/18/00 | 3075 | 26-17-34 | 97-01-31 | 23.9 | 6.2 | 37 |
| 5/11/00 | 3248 | 26-00.511 | 97-59.542 | 25.9 | 6 | 35 |
| 5/16/00 | 3062 | 26-18.544 | 97-03.318 | 25.9 | 7.7 | 37 |
| 6/3/00 | N/A | 26-06-36 | 97-09-50 | 27.3 | 6 | 35.4 |
| 6/13/00 | 3257 | 25-59.654 | 97-00.637 | 26.4 | 6.9 | 36 |
| 6/26/00 | 3156 | 26-09.549 | 97-00.527 | 24.8 | 9.7 | 35 |
| 7/3/00 | 349 | 26-07-23 | 97-09-58 | 30.6 | 7.2 | 36 |
| 7/5/00 | 3228 | 26-02.451 | 97-59.534 | 24.9 | 8.1 | 36 |
| 7/10/00 | 2981 | 26-25-10 | 97-13-35 | 0 | 0 | 36 |
| 7/18/00 | 3085 | 26-16-37 | 97-01-30 | 22.9 | 6.2 | 36 |
| 8/4/00 | 3187 | 26-06-30 | 96-59-31 | 27.2 | 6.5 | 36 |

| Date | Grid | Latitude | Longitude | Temp (°C) | DO (ppm) | Salinity (ppt) |
|---|---|---|---|---|---|---|
| 8/28/00 | 3125 | 26-12-44 | 97-01-35 | 26.7 | 7.3 | 36 |
| 9/6/00 | 3197 | 26-05- | 97-00- | 25.2 | 6.1 | 36 |
| 9/28/00 | 3094 | 26-15-29 | 97-02-33 | 22.7 | 4.8 | 36 |
| 10/13/00 | 3247 | 26-00-450 | 97-00-557 | 23 | 5.9 | 34.7 |
| 10/13/00 | 3188 | 26-05- | 97-09- | 23.7 | 6.9 | 34.4 |
| 10/16/00 | 3146 | 26-10-475 | 97-00-468 | 23.9 | 5.6 | 36 |
| 11/15/00 | 3187 | 26-06-39 | 96-59-42 | 22.5 | 6.2 | 34.6 |
| 11/22/00 | 3144 | 26-10-39 | 97-02-37 | 19.9 | 6.5 | 34 |
| 12/6/00 | 3257 | 25-59-33 | 97-00-29 | 18.5 | 6.7 | 34.1 |
| 12/28/00 | 3063 | 26-18-30 | 97-02-26 | 15.4 | 8.6 | 34.7 |
| 1/5/01 | 3095 | 26-15-31 | 97-01-26 | 13.4 | 8.5 | 34.1 |
| 1/16/01 | 3258 | 25-59-29 | 96-59-24 | 13.2 | 8.3 | 36.6 |
| 2/5/01 | 3165 | 26-08-459 | 97-01-517 | 15.1 | 8.9 | 35.3 |
| 2/20/01 | 3095 | 26-15-28 | 97-01-26 | 14.8 | 8.3 | 34 |
| 3/6/01 | 3208 | 26-04-31 | 96-59-34 | 16.2 | 8.1 | 35 |
| 3/30/01 | 3105 | 26-14-30 | 97-01-30 | 18.1 | 8.2 | 31 |
| 4/10/01 | 3268 | 25-58-24 | 96-59-32 | 20.3 | 6.4 | 32.7 |

Appendix 3. Nutrient data for Areas 17-21. All concentrations are in micromoles per liter.

Abbreviations:

Nit = nitrate + nitrite

Si = silicate

PO = inorganic phosphate

NH = ammonium

Table 1. Nutrient data from Area 17, Sabine Pass

| Date | Grid | Nit avg | Nit s.e. | Si avg | Si s.e. | PO avg | PO s.e. | NH avg | NH s.e. |
|---|---|---|---|---|---|---|---|---|---|
| 11/3/98 | 212 | 2.76 | 2.37 | 21.72 | 2.2 | 0.19 | 0.05 | 0.02 | 0 |
| 11/16/98 | 3779 | 10.16 | 0.06 | 30.06 | 0.99 | 0.43 | 0.01 | 0.02 | 0 |
| 12/2/98 | 205 | 1.01 | 0.14 | 41.02 | 0.72 | 0.13 | 0.03 | 0.02 | 0 |
| 12/16/98 | 3778 | 2.53 | 0.03 | 17.73 | 1.11 | 0.14 | 0 | 0.02 | 0 |
| 1/11/99 | 201 | 0.04 | 0 | 18.88 | 0 | 0.08 | 0 | 0.32 | 0 |
| 1/19/99 | 3743 | 0.07 | 0.03 | 13.32 | 0.04 | 0.04 | 0.01 | 0.39 | 0.01 |
| 2/1/99 | 3778 | 0.2 | 0.02 | 10.19 | 0.16 | 0.08 | 0 | 0.27 | 0.02 |
| 2/18/99 | 3489 | 1.96 | 0.02 | 20.36 | 0.06 | 0.06 | 0 | 0.19 | 0 |
| 3/9/99 | 3491 | 7.17 | 0.14 | 29.86 | 0.1 | 0.23 | 0.01 | 0.11 | 0.11 |
| 3/22/99 | 240 | 8.99 | 0.02 | 36.42 | 0.06 | 0.07 | 0 | 0.22 | 0 |
| 4/6/99 | 174 | 3.74 | 0 | 51.28 | 1.63 | 0.98 | 0.01 | 1.28 | 0.07 |
| 4/27/99 | 212 | 0.14 | 0.11 | 45.14 | 0.55 | 0.25 | 0 | 0.52 | 0.05 |
| 5/7/99 | 3754 | 1.2 | 0.63 | 46.81 | 1.25 | 0.37 | 0.01 | 1.33 | 0.16 |
| 5/19/99 | 3790 | 0.73 | 0.22 | 39.54 | 0.77 | 0.16 | 0.02 | 0.33 | 0.08 |
| 6/7/99 | 243 | 0.2 | 0.06 | 39.82 | 0.59 | 0.18 | 0.02 | 0.47 | 0.02 |
| 6/16/99 | 3778 | 0.1 | 0.07 | 36.52 | 0.52 | 0.19 | 0.01 | 1.13 | 0.06 |
| 7/6/99 | 167 | 21.01 | 0.43 | 52.97 | 1.88 | 0.1 | 0.04 | 0.83 | 0.2 |
| 7/16/99 | 3790 | 0.46 | 0.06 | 33.53 | 0.4 | 0.05 | 0.05 | 0.61 | 0.14 |
| 8/2/99 | 138 | 1.31 | 0.05 | 16.12 | 1.63 | 0.36 | 0.02 | 0.43 | 0.32 |
| 8/17/99 | 3488 | 0.2 | 0.03 | 19.06 | 0.03 | 0.2 | 0.01 | 0 | 0 |
| 9/7/99 | 101 | 0.18 | 0.06 | 41.72 | 0.49 | 0.32 | 0.03 | 0.69 | 0.42 |
| 9/28/99 | 3764 | 0.43 | 0.01 | 12.67 | 0.27 | 0.27 | 0.01 | 1.46 | 0.01 |
| 10/11/99 | 3491 | 0.2 | 0.2 | 3.42 | 0.12 | 0.39 | 0.01 | 2.38 | 0 |
| 10/25/99 | 3767 | 0 | 0 | 3.64 | 0.04 | 0.2 | 0.01 | 1.19 | 0.19 |
| 11/1/99 | 105 | 0.52 | 0.13 | 8.64 | 0.3 | 0.4 | 0.02 | 0.59 | 0.59 |
| 11/17/99 | 3772 | 0.03 | 0.03 | 7.02 | 0.4 | 0.35 | 0.02 | 0.08 | 0.08 |
| 12/7/99 | 204 | 0.15 | 0.03 | 7.02 | 0.4 | 0.3 | 0.01 | 0.7 | 0.02 |
| 12/10/99 | 211 | 1.44 | 0 | 12.66 | 0.13 | 0.36 | 0.01 | 1.07 | 0.02 |
| 1/11/00 | 3492 | 0.03 | 0.02 | 3.92 | 0.31 | 0.13 | 0.02 | 0.67 | 0 |
| 1/17/00 | 3790 | 0.39 | 0.11 | 4.41 | 1.11 | 0.29 | 0.03 | 1.79 | 0.17 |
| 2/9/00 | 131 | 0 | 0 | 7.67 | 0.69 | 0.09 | 0.02 | 0 | 0 |
| 2/16/00 | 211 | 0.08 | 0.01 | 6.86 | 0.07 | 0.01 | 0.01 | 0.11 | 0.02 |
| 3/9/00 | 3492 | 0.33 | 0.01 | 20.36 | 0.95 | 0.31 | 0.04 | 1.13 | 0.1 |
| 3/20/00 | 3753 | 11.71 | 0.96 | 26.01 | 2.06 | 0.12 | 0.05 | 1.01 | 0.14 |
| 4/5/00 | 175 | 3.8 | 0.22 | 23.71 | 2.04 | 0.17 | 0.01 | 1.61 | 0.2 |
| 4/18/00 | 3771 | 0.48 | 0.03 | 14.74 | 0.03 | 0.04 | 0.01 | 0.19 | 0.03 |
| 5/15/00 | 99 | 13.27 | 0.66 | 43.5 | 0.24 | 0.96 | 0.02 | 1.32 | 0 |
| 5/22/00 | 211 | 0 | 0 | 22.27 | 0.02 | 0.04 | 0.01 | 0.62 | 0.06 |
| 6/1/00 | 206 | 0.11 | 0.01 | 50.46 | 14.75 | 0.04 | 0.01 | 0.15 | 0.06 |
| 6/22/00 | 3491 | 0.07 | 0.01 | 14.05 | 1.29 | 0.05 | 0.02 | 0.16 | 0 |
| 7/6/00 | 210 | 0.09 | 0 | 66.94 | 0 | 0.1 | 0 | 0.47 | 0 |
| 7/17/00 | 212 | 0.26 | 0 | 55.93 | 0 | 0.16 | 0 | 1.27 | 0 |
| 8/3/00 | 172 | 0.12 | 0 | 44.09 | 0 | 0.23 | 0 | 0.42 | 0 |
| 8/16/00 | 3731 | 0.33 | 0 | 95.22 | 0 | 0.7 | 0 | 1.52 | 0 |
| 9/11/00 | 3783 | 0.18 | 0.01 | 27.8 | 0.28 | 0.74 | 0.02 | 0.75 | 0.27 |
| 9/18/00 | 175 | 1.03 | 0.03 | 19.07 | 0.11 | 0.61 | 0.02 | 1.47 | 0.01 |
| 10/4/00 | 3491 | 0.55 | 0.07 | 10.29 | 0.43 | 0.41 | 0.02 | 0.86 | 0.06 |

| Date | Grid | Nit avg | Nit s.e. | Si avg | Si s.e. | PO avg | PO s.e. | NH avg | NH s.e. |
|---|---|---|---|---|---|---|---|---|---|
| 10/17/00 | 3779 | 0.31 | 0.05 | 10.89 | 2.29 | 0.36 | 0.03 | 0.79 | 0.51 |
| 11/10/00 | 107 | 7.79 | 0.14 | 22.46 | 0.08 | 0.95 | 0 | 0.9 | 0.01 |
| 11/20/00 | 3786 | 3.45 | 0.14 | 11.61 | 0.48 | 0.42 | 0.06 | 1.11 | 0.09 |
| 12/6/00 | 211 | 0.32 | 0.06 | 3.36 | 0.14 | 0.26 | 0.01 | 0.83 | 0.14 |
| 12/29/00 | 3768 | 4.47 | 0.02 | 13.2 | 0.21 | 0.47 | 0.01 | 1.98 | 0 |
| 1/4/01 | 205 | 4.46 | 0.09 | 12.76 | 0.62 | 0.37 | 0.02 | 0.32 | 0.04 |
| 1/23/01 | 3488 | 0.58 | 0.03 | 12.47 | 0.09 | 1.86 | 0.01 | 0.49 | 0.08 |
| 2/5/01 | 134 | 0.24 | 0.08 | 121.58 | 0.96 | 1.25 | 0.05 | 0.06 | 0.02 |
| 2/19/01 | 3760 | 2.99 | 0.11 | 82.14 | 0.58 | 0.15 | 0.03 | 0.35 | 0.04 |
| 3/5/01 | 243 | 5.27 | 0.02 | 205.99 | 2.83 | 0.71 | 0.17 | 3.93 | 0.14 |
| 3/21/01 | 3740 | 8.3 | 0.22 | 115.31 | 4.64 | 0.33 | 0.03 | 2.09 | 0.03 |
| 4/4/01 | 243 | 0.7 | 0.02 | 161.61 | 8.5 | 0.3 | 0.07 | 0.39 | 0.03 |

Table 2. Nutrient data from Area 18, Bolivar Roads Pass

| Date | Grid | Nit avg | Nit s.e. | Si avg | Si s.e. | PO avg | PO s.e. | NH avg | NH s.e. |
|---|---|---|---|---|---|---|---|---|---|
| 11/3/98 | 486 | 1.84 | 0.78 | 20.52 | 1.57 | 0.27 | 0.01 | 0.36 | 0 |
| 11/16/98 | 635 | 12.41 | 0.07 | 47.79 | 0.23 | 1.54 | 0.06 | 0.02 | 0 |
| 12/1/98 | 483 | 10.37 | 0.18 | 42.77 | 1.08 | 0.99 | 0.16 | 1.08 | 0 |
| 12/16/98 | 711 | 7.38 | 0 | 7.38 | 0 | 0.58 | 0 | 2.15 | 0 |
| 1/11/99 | 475 | 1.23 | 0.07 | 26.67 | 0.1 | 0.5 | 0.01 | 0.54 | 0.25 |
| 1/19/99 | 652 | 1.42 | 0.01 | 25.56 | 0.05 | 0.25 | 0 | 0.35 | 0.11 |
| 2/17/99 | 671 | 0.97 | 0.03 | 32.84 | 0.01 | 0.32 | 0.02 | 0.11 | 0.06 |
| 3/10/99 | 606 | 8.58 | 0.32 | 50.55 | 0.03 | 0.53 | 0.01 | 0.22 | 0 |
| 3/16/99 | 433 | 7 | 0.03 | 34.3 | 0.1 | 0.39 | 0.01 | 2.54 | 0.85 |
| 4/6/99 | 671 | 17.68 | 0.38 | 42.57 | 2.55 | 0.43 | 0.07 | 1.74 | 0.66 |
| 4/27/99 | 458 | 0.12 | 0.05 | 11.83 | 1.41 | 0.21 | 0.01 | 0.3 | 0.14 |
| 5/13/99 | 474 | 0.17 | 0.05 | 34.04 | 0.59 | 0.43 | 0.05 | 16.84 | 0.03 |
| 5/25/99 | 615 | 0.15 | 0.01 | 24.75 | 0.42 | 0.76 | 0.11 | 6.01 | 3 |
| 6/10/99 | 474 | 0.18 | 0.05 | 18.32 | 0.07 | 0.12 | 0.01 |  | ? |
| 7/8/99 | 458 | 8.49 | 0 | 120.82 | 30.48 | 0 | 0 | 1.15 | 0.01 |
| 7/27/99 | 636 | 0.13 | 0.05 | 11.74 | 1.51 | 0.1 | 0.1 | 1.86 | 0.04 |
| 8/3/99 | 485 | 1.51 | 0.56 | 7.21 | 0.1 | 1.6 | 0.46 | 6.35 | 1.37 |
| 8/16/99 | 693 | 0.83 | 0.19 | 12.02 | 0.45 | 0.16 | 0.01 | 0 | 0 |
| 9/7/99 | 668 | 3.32 | 0.28 | 24.54 | 0.12 | 0.55 | 0.06 | 1.8 | 0.29 |
| 9/20/99 | 563 | 7.27 | 1.06 | 25.06 | 1.73 | 0.34 | 0.04 | 1.87 | 0 |
| 10/13/99 | 473 | 2.21 | 0.02 | 26.52 | 0.96 | 1.4 | 0.03 | 0.97 | 0.31 |
| 10/25/99 | 688 | 0.1 | 0 | 6.8 | 0.38 | 0.22 | 0 | 1.87 | 0.37 |
| 11/4/99 | 411 | 1.15 | 0.3 | 3.75 | 0.21 | 0.38 | 0.05 | 0.82 | 0.82 |
| 12/1/99 | 624 | 1.41 | 0.18 | 15.03 | 0.26 | 0.57 | 0.02 | 5.21 | 1.56 |
| 12/14/99 | 474 | 1.82 | 0.76 | 14.3 | 0.12 | 0.59 | 0.11 | 1.21 | 0 |
| 12/16/99 | 692 | 1.39 | 0.01 | 14.3 | 0.12 | 0.32 | 0.02 | 11.79 | 4.61 |
| 1/11/00 | 408 | 1.25 | 0.47 | 3.38 | 0.08 | 0.36 | 0.03 | 23.78 | 15.95 |
| 1/25/00 | 650 | 1.79 | 0.22 | 3.38 | 0.08 | 0.21 | 0.05 | 0.33 | 0.11 |
| 3/1/00 | 648 | 1.21 | 0.03 | 17.75 | 0.17 | 0.35 | 0 | 1.28 | 0.02 |
| 3/13/00 | 457 | 0.9 | 0.05 | 17.75 | 0.17 | 0.37 | 0.02 | 0.61 | 0 |
| 3/24/00 | 674 | 5.23 | 0.49 | 16 | 2.41 | 0.14 | 0.07 | 0.28 | 0.27 |
| 4/5/00 | 542 | 1.43 | 0.25 | 5.47 | 0.22 | 0.18 | 0.02 | 0.98 | 0.4 |
| 4/19/00 | 636 | 0.22 | 0.06 | 3.51 | 0.18 | 0.12 | 0.02 | 11.4 | 0.45 |
| 5/11/00 | 385 | 1.94 | 0.03 | 24.88 | 0.34 | 0.45 | 0.04 | 0.41 | 0.08 |
| 5/22/00 | 711 | 0.8 | 0.31 | 5.08 | 0.41 | 0.25 | 0.07 | 1.65 | 0.45 |
| 6/13/00 | 436 | 1 | 0.03 | 15.53 | 0.17 | 0.38 | 0.01 | 0.35 | 0.01 |
| 7/5/00 | 458 | 0.13 | 0.07 | 5.61 | 0.3 | 0.04 | 0.01 | 0.1 | 0.06 |
| 7/17/00 | 692 | 0.25 | 0 | 7.9 | 1.71 | 0.03 | 0 | 0.24 | 0.02 |
| 8/1/00 | 384 | 0.16 | 0 | 1.86 | 1.91 | 0.16 | 0.08 | 0.76 | 0.22 |
| 8/21/00 | 693 | 0.37 | 0 | 29.75 | 0 | 0.22 | 0 | 0.99 | 0 |
| 9/5/00 | 670 | 0.27 | 0.01 | 8.25 | 0.02 | 0.12 | 0.02 | 1.45 | 1.06 |
| 9/27/00 | 468 | 0.6 | 0.03 | 11.18 | 0.25 | 0.53 | 0.05 | 0.71 | 0.04 |
| 10/12/00 | 411 | 4.18 | 0.08 | 12.99 | 0.02 | 0.99 | 0 | 0.65 | 0.03 |
| 11/15/00 | 328 | 11.31 | 1.17 | 18.46 | 5.99 | 0.82 | 0.07 | 1.52 | 1.42 |
| 11/28/00 | 692 | 3.13 | 0.03 | 8.37 | 0.2 | 0.48 | 0.03 | 2.39 | 1.99 |
| 12/7/00 | 487 | 0.4 | 0.03 | 7.7 | 0.04 | 0.42 | 0 | 0.16 | 0.06 |
| 12/29/00 | 674 | 0.65 | 0.04 | 5.99 | 0.28 | 0.39 | 0.01 | 9.26 | 2.69 |

| Date | Grid | Nit avg | Nit s.e. | Si avg | Si s.e. | PO avg | PO s.e. | NH avg | NH s.e. |
|---|---|---|---|---|---|---|---|---|---|
| 1/15/01 | 692 | 0.4 | 0.05 | 10.25 | 0.18 | 0.36 | 0.03 | 0.63 | 0.46 |
| 1/22/01 | 533 | 0.28 | 0.04 | 12.69 | 0.68 | 0.31 | 0.03 | 0.35 | 0.13 |
| 2/5/01 | 329 | 2.1 | 0.03 | 11.76 | 0.06 | 0.54 | 0.03 | 0.58 | 0.16 |
| 2/20/01 | 691 | 0.3 | 0.01 | 61.42 | 4.72 | 0.1 | 0 | 0.05 | 0.01 |
| 3/5/01 | 692 | 5.25 | 0.09 | 77.09 | 0.17 | 0.44 | 0.01 | 6.07 | 0.65 |
| 3/30/01 | 435 | 2.54 | 0.21 | 25.58 | 1.24 | 0.35 | 0 | 1.06 | 0.04 |
| 4/2/01 | 521 | 6.99 | 0.29 | 159.94 | 5.57 | 0.33 | 0.02 | 0.37 | 0.06 |

Table 3. Nutrient data from Area 19, Cavallo Pass

| Date | Grid | Nit avg | Nit s.e. | Si avg | Si s.e. | PO avg | PO s.e. | NH avg | NH s.e. |
|---|---|---|---|---|---|---|---|---|---|
| 11/2/98 | 1586 | 1.28 | 0.38 | 11.36 | 0.12 | 0.15 | 0.01 | 0.02 | 0 |
| 11/16/98 | 1721 | 8.49 | 0.03 | 52.94 | 1.04 | 0.88 | 0.02 | 0.05 | 0.03 |
| 12/1/98 | 1587 | 0.08 | 0.02 | 14.18 | 0.73 | 0.02 | 0 | 0.02 | 0 |
| 12/16/98 | 1721 | 2.76 | 0.02 | 16.35 | 0.23 | 0.19 | 0 | 0.02 | 0 |
| 1/5/99 | 1554 | 1.11 | 0.03 | 18.16 | 0.03 | 0.17 | 0 | 0.32 | 0 |
| 1/18/99 | 1721 | 0.08 | 0.03 | 4.8 | 0.04 | 0.04 | 0.01 | 0.12 | 0.01 |
| 2/1/99 | 1512 | 0.12 | 0.02 | 6.54 | 0 | 0.03 | 0.01 | 1.11 | 0.01 |
| 2/18/99 | 1630 | 0.1 | 0.03 | 6.11 | 0.01 | 0.04 | 0 | 0 | 0 |
| 3/9/99 | 1585 | 1.38 | 0.01 | 22.45 | 0.02 | 0.1 | 0.01 | 0.19 | 0 |
| 3/16/99 | 1700 | 0.16 | 0.03 | 23.22 | 0.09 | 0.03 | 0 | 0.35 | 0.35 |
| 4/6/99 | 1599 | 5.11 | 0.02 | 24.24 | 0.01 | 0.14 | 0 | 0.11 | 0.11 |
| 4/19/99 | 1719 | 0.11 | 0.01 | 7.66 | 0.08 | 0.1 | 0.01 | 0.53 | 0.02 |
| 5/5/99 | 1553 | 0.11 | 0 | 13.23 | 0.22 | 0.08 | 0 | 0.14 | 0.01 |
| 5/19/99 | 1701 | 0.17 | 0.05 | 19.45 | 3.17 | 0.11 | 0.03 | 0.64 | 0.2 |
| 6/1/99 | 1570 | 0.11 | 0.01 | 6.84 | 0.06 | 0.05 | 0.03 | 0.18 | 0.03 |
| 6/16/99 | 1761 | 0.2 | 0.09 | 3.4 | 0.08 | 0.02 | 0.01 | 0.23 | 0.02 |
| 7/6/99 | 1535 | 0 | 0 | 3.11 | 0.17 | 0 | 0 | 0.42 | 0.02 |
| 7/20/99 | 1715 | 0.01 | 0.01 | 10.41 | 1.09 | 0.02 | 0.01 | 0.44 | 0.04 |
| 8/2/99 | 1681 | 0.08 | 0.03 | 5.98 | 0.43 | 0.09 | 0.03 | 0 | 0 |
| 8/16/99 | 1760 | 0.03 | 0.02 | 8.44 | 0.2 | 0.06 | 0 | 0 | 0 |
| 9/1/99 | 1582 | 0.03 | 0.02 | 14.02 | 0.01 | 0.15 | 0 | 0 | 0 |
| 9/20/99 | 1719 | 0 | 0 | 5.22 | 0.02 | 0.03 | 0.01 | 0.09 | 0.08 |
| 10/2/99 | 1554 | 0 | 0 | 11.15 | 0.46 | 0.06 | 0.01 | 0.14 | 0.14 |
| 10/21/99 | 1614 | 0.01 | 0.01 | 3.52 | 0.18 | 0.12 | 0.01 | 0.14 | 0.14 |
| 11/1/99 | 1572 | 0 | 0 | 2.3 | 0.02 | 0.04 | 0.01 | 0.2 | 0.2 |
| 11/16/99 | 1759 | 0.05 | 0.05 | 5.4 | 0.06 | 0.15 | 0 | 0.2 | 0.2 |
| 12/6/99 | 1596 | 0.49 | 0.01 | 12.64 | 0.05 | 0.23 | 0.02 | 0.42 | 0.11 |
| 12/16/99 | 1736 | 0.45 | 0.01 | 10.01 | 0.01 | 0.16 | 0.01 | 0.29 | 0.02 |
| 1/6/00 | 1582 | 0.17 | 0.01 | 8.49 | 0.43 | 0.22 | 0.01 | 0.19 | 0.03 |
| 1/17/00 | 1676 | 0.01 | 0.01 | 9.89 | 0.13 | 0.22 | 0 | 0.23 | 0.01 |
| 2/6/00 | 1508 | 0.22 | 0.02 | 6.39 | 0.15 | 0.17 | 0.02 | 0.09 | 0.03 |
| 2/16/00 | 1698 | 0 | 0 | 6.2 | 0.21 | 0.18 | 0 | 0.21 | 0.21 |
| 3/8/00 | 1572 | 0.02 | 0.01 | 6.7 | 0.1 | 0.25 | 0 | 0.14 | 0.12 |
| 3/27/00 | 1714 | 0.06 | 0.06 | 7.17 | 0.43 | 0.04 | 0 | 0.21 | 0.21 |
| 4/13/00 | 1466 | 0.14 | 0.03 | 4.79 | 0.1 | 0.12 | 0.01 | 0.02 | 0.02 |
| 4/16/00 | 1760 | 0 | 0 | 4.35 | 0.19 | 0.03 | 0.03 | 0 | 0 |
| 5/16/00 | 1615 | 0 | 0 | 10.66 | 0.08 | 0.05 | 0.05 | 0.13 | 0.05 |
| 5/21/00 | 1717 | 0 | 0 | 7.04 | 0.05 | 0.02 | 0.01 | 0.08 | 0.01 |
| 6/13/00 | 1534 | 0.08 | 0.01 | 5.16 | 0.22 | 0.19 | 0.02 | 0.17 | 0.05 |
| 6/27/00 | 1801 | 0.07 | 0.02 | 16.04 | 1.46 | 0.09 | 0.01 | 0.13 | 0.07 |
| 7/5/00 | 1583 | 0.19 | 0.01 | 38.67 | 0.34 | 0.24 | 0.01 | 0.25 | 0.01 |
| 7/18/00 | 1782 | 0.03 | 0 | 18.19 | 0 | 0.05 | 0 | 0.09 | 0 |
| 8/1/00 | 1552 | 0.1 | 0.01 | - | 0.02 | 0.11 | 0.01 | -0.03 | 0.06 |
| 8/16/00 | 1659 | 0.08 | 0 | 31.09 | 0 | 0.24 | 0 | 0.07 | 0 |
| 9/9/00 | 1535 | 0.08 | 0.01 | 5.05 | 0.1 | 0.09 | 0.01 | 0.07 | 0.09 |
| 9/19/00 | 1801 | 0.08 | 0.03 | 4.71 | 0.43 | 0.09 | 0.01 | 0.16 | 0.12 |
| 10/2/00 | 1554 | 0.06 | 0.01 | 10.67 | 0.16 | 0.23 | 0.01 | 0.16 | 0.05 |

| Date | Grid | Nit avg | Nit s.e. | Si avg | Si s.e. | PO avg | PO s.e. | NH avg | NH s.e. |
|---|---|---|---|---|---|---|---|---|---|
| 10/18/00 | 1762 | 0.07 | 0.04 | 6.28 | 0.03 | 0.09 | 0.01 | 0 | 0.24 |
| 11/10/00 | 1569 | 0.19 | 0.01 | 8.28 | 0 | 0.33 | 0.03 | 0.03 | 0.11 |
| 11/20/00 | 1693 | 8.09 | 0.07 | 15.11 | 0.15 | 0.81 | 0.03 | 0.81 | 0.01 |
| 12/5/00 | 1586 | 1.66 | 0.04 | 9.57 | 0.05 | 0.46 | 0.03 | 1.27 | 0.17 |
| 12/19/00 | 1720 | 0.25 | 0.04 | 7.93 | 0.6 | 0.33 | 0.02 | 0.1 | 0.01 |
| 1/4/01 | 1701 | 0.17 | 0.02 | 15.57 | 1.58 | 0.17 | 0.04 | 0.53 | 0.52 |
| 1/22/01 | 1587 | 0.03 | 0.01 | 24.97 | 1.79 | 1.3 | 1.2 | -0.15 | 0.01 |
| 2/12/01 | 1758 | 0.09 | 0.01 | 37.95 | 0.2 | 0.25 | 0.06 | -0.15 | 0.04 |
| 2/20/01 | 1585 | 0.49 | 0.01 | 28.2 | 0.25 | 0.15 | 0.01 | 0.1 | 0 |
| 3/5/01 | 1570 | 1.57 | 0.04 | 65.27 | 1.2 | 2.41 | 1.94 | 0.12 | 0.01 |
| 3/21/01 | 1646 | 2.58 | 0.03 | 56.98 | 0.06 | 0.34 | 0.02 | 0.43 | 0.02 |
| 4/10/01 | 1587 | 0.12 | 0 | 0.96 | 0.05 | 0.18 | 0.03 | 0.3 | 0.15 |

Table 4. Nutrient data from Area 20, Port Aransas Pass

| Date | Grid | Nit avg | Nit s.e. | Si avg | Si s.e. | PO avg | PO s.e. | NH avg | NH s.e. |
|---|---|---|---|---|---|---|---|---|---|
| 11/15/98 | 2118 | 2.58 | 0 | 17.71 | 0.67 | 0.29 | 0 | 0.02 | 0 |
| 11/16/98 | 2238 | 20.01 | 0.2 | 20.32 | 0.89 | 0.24 | 0.01 | 0.02 | 0 |
| 12/1/98 | 2131 | 16.18 | 0.15 | 57 | 2.66 | 0.59 | 0 | 0.02 | 0 |
| 12/16/98 | 2226 | 7.78 | 0.44 | 12.33 | 0.45 | 0.16 | 0.01 | 0.02 | 0 |
| 1/5/99 | 2081 | 4.58 | 0.12 | 26.95 | 0.04 | 0.05 | 0 | 3.21 | 1.17 |
| 1/16/99 | 2190 | 0.64 | 0.13 | 16.87 | 0.66 | 0.09 | 0.01 | 1.26 | 0.15 |
| 2/14/99 | 2249 | 1.07 | 0.05 | 9.57 | 0.01 | 0.12 | 0 | 2 | 0.67 |
| 2/18/99 | 2130 | 0.43 | 0.02 | 6.34 | 0.01 | 0.1 | 0 | 0 | 0 |
| 3/24/99 | 2118 | 0.85 | 0.04 | 17.26 | 1.14 | 0.07 | 0.01 | 0 | 0 |
| 4/6/99 | 2154 | 0.35 | 0.01 | 3.06 | 0.01 | 0.03 | 0 | 0.13 | 0.13 |
| 4/27/99 | 2247 | 0.15 | 0.01 | 12.1 | 0.05 | 0.04 | 0 | 0.55 | 0.04 |
| 5/5/99 | 2248 | 0.07 | 0.03 | 10.46 | 0.22 | 0.19 | 0 | 2.47 | 0.03 |
| 5/19/99 | 2032 | 0.19 | 0.03 | 11.32 | 0.38 | 0.13 | 0 | 0.98 | 0.02 |
| 6/8/99 | 2202 | 0.17 | 0.08 | 4.11 | 0.11 | 0.02 | 0.01 | 0.64 | 0.02 |
| 7/6/99 | 2117 | 0.14 | 0.01 | 6.93 | 0.01 | 0 | 0 | 1.48 | 0.01 |
| 7/28/99 | 2226 | 0.2 | 0.07 | 4.77 | 2.16 | 0.16 | 0 | 4.24 | 2.75 |
| 8/4/99 | 2070 | 1.34 | 0.07 | 7.19 | 0.1 | 0.09 | 0.02 | 0 | 0 |
| 8/17/99 | 2238 | 0.59 | 0.07 | 5.5 | 0.03 | 0.05 | 0.01 | 5.58 | 2.53 |
| 9/9/99 | 2031 | 1.35 | 0.04 | 9.93 | 0.29 | 0.21 | 0.02 | 0 | 0 |
| 9/20/99 | 2214 | 0.91 | 0.03 | 3.18 | 0.05 | 0.17 | 0.01 | 0 | 0 |
| 10/11/99 | 2127 | 0.05 | 0.05 | 10.13 | 0.41 | 0.14 | 0.01 | 0.03 | 0.03 |
| 10/22/99 | 2203 | 0.35 | 0.02 | 6.21 | 0.02 | 0.12 | 0.02 | 1.52 | 0.16 |
| 11/8/99 | 2070 | 0.27 | 0.06 | 2.95 | 0 | 0.05 | 0 | 0.55 | 0.02 |
| 11/23/99 | 2247 | 0.01 | 0.01 | 3.71 | 0.02 | 0.05 | 0 | 1.16 | 0.77 |
| 12/7/99 | 2068 | 0.23 | 0.03 | 8.35 | 0.43 | 0.13 | 0.05 | 0.32 | 0.03 |
| 12/17/99 | 2190 | 0.77 | 0.01 | 9.02 | 0.2 | 0.12 | 0.03 | 0.19 | 0.01 |
| 1/6/00 | 2032 | 0.89 | 0.05 | 7.44 | 0.21 | 0.07 | 0.02 | 0.17 | 0.03 |
| 1/25/00 | 2144 | 0.3 | 0.06 | 11.46 | 0.64 | 0.21 | 0.07 | 0.27 | 0.04 |
| 2/8/00 | 2202 | 0.57 | 0.03 | 7.02 | 0.42 | 0.19 | 0 | 0.24 | 0.02 |
| 2/22/00 | 2058 | 0.27 | 0.02 | 6.95 | 0.34 | 0.14 | 0.03 | 0.46 | 0 |
| 3/1/00 | 2130 | 1.8 | 0.08 | 11.57 | 0.58 | 0.22 | 0.01 | 0.91 | 0.1 |
| 3/24/00 | 2118 | 0.34 | 0 | 10.56 | 0.42 | 0.03 | 0.02 | 0.05 | 0.02 |
| 4/13/00 | 2083 | 0.62 | 0.01 | 3.1 | 0.01 | 0 | 0 | 0.53 | 0.02 |
| 4/17/00 | 2188 | 0.78 | 0.04 | 4.2 | 1 | 0.01 | 0.01 | 0.02 | 0.02 |
| 5/10/00 | 2237 | 0.37 | 0.02 | 8.14 | 0.06 | 0.09 | 0.08 | 0.09 | 0.02 |
| 5/21/00 | 2046 | 0 | 0 | 5.64 | 0.38 | 0.04 | 0.04 | 0.18 | 0.07 |
| 6/6/00 | 2070 | 0.08 | 0.03 | 3.67 | 0.21 | 0.08 | 0.01 | 0.26 | 0.09 |
| 6/27/00 | 2131 | 0.01 | 0 | 11.47 | 3.88 | 0.05 | 0 | 0.95 | 0.02 |
| 7/5/00 | 2055 | 0.87 | 0.51 | 9.94 | 0.79 | 0.1 | 0 | 0 | 0.03 |
| 7/17/00 | 2155 | 0.34 | 0 | 12.35 | 0 | 0.09 | 0 | 3.12 | 0 |
| 8/2/00 | 2192 | 0.29 | 0.01 | - | 0 | 0.09 | 0 | 0.12 | 0.01 |
| 8/23/00 | 2102 | 0.2 | 0 | 10.3 | 0 | 0.06 | 0 | 0.36 | 0 |
| 9/5/00 | 2180 | 0.12 | 0.04 | 17.59 | 0.03 | 0.04 | 0.01 | 0.19 | 0.02 |
| 9/27/00 | 2045 | 1.37 | 0.03 | 6.47 | 0.16 | 0.23 | 0.03 | 0.14 | 0.09 |
| 10/13/00 | 2033 | 1.26 | 0.01 | 12.63 | 0.03 | 0.33 | 0.01 | 0.76 | 0.05 |
| 10/19/00 | 2226 | 0.27 | 0.02 | 12.16 | 0.02 | 0.43 | 0.01 | 0.58 | 0.02 |
| 11/11/00 | 2179 | 1.26 | 0 | 11.28 | 0.04 | 0.31 | 0.01 | 0.26 | 0.01 |

| Date | Grid | Nit avg | Nit s.e. | Si avg | Si s.e. | PO avg | PO s.e. | NH avg | NH s.e. |
|---|---|---|---|---|---|---|---|---|---|
| 11/21/00 | 2131 | 1.27 | 0 | 5.94 | 0.07 | 0.34 | 0.01 | 0.92 | 0.01 |
| 12/5/00 | 2105 | 2.29 | 0.19 | 7.86 | 0.53 | 0.28 | 0.01 | 0.66 | 0 |
| 12/16/00 | 2236 | 2.17 | 0.01 | 8.26 | 0.08 | 0.34 | 0.02 | 0.49 | 0.02 |
| 1/4/01 | 2033 | 0.29 | 0.06 | 15.61 | 0.75 | 3.21 | 3.09 | 0.25 | 0.14 |
| 1/12/01 | 2191 | 0.33 | 0.03 | 26.64 | 0.03 | 2.52 | 2.45 | 0 | 0.03 |
| 2/12/01 | 2177 | 0.17 | 0.01 | 31.1 | 0.77 | 0.08 | 0.01 | 0.02 | 0 |
| 2/19/01 | 2116 | 0.2 | 0.01 | 13.99 | 0.66 | 0.85 | 0.07 | 0.13 | 0.01 |
| 3/5/01 | 2156 | 0.84 | 0.01 | 41.48 | 1.05 | 0.18 | 0 | 0.35 | 0.02 |
| 3/21/01 | 2212 | 1.29 | 0.02 | 44.51 | 0.91 | 0.27 | 0.03 | 0.06 | 0.02 |
| 4/12/01 | 2080 | 0.21 | 0.02 | 12.09 | 0.01 | 0.17 | 0.01 | 0.14 | 0.03 |

Table 5. Nutrient data from Area 21, Brazos Santiago Pass

| Date | Grid | Nit avg | Nit s.e. | Si avg | Si s.e. | PO avg | PO s.e. | NH avg | NH s.e. |
|---|---|---|---|---|---|---|---|---|---|
| 11/13/98 | 3198 | 2.1 | 0.1 | 16.9 | 1.5 | 0.19 | 0 | 0.02 | 0 |
| 11/17/98 | 3136 | 1.86 | 0.22 | 13.86 | 2.12 | 0.17 | 0.01 | 0.02 | 0 |
| 12/2/98 | 3145 | 0.14 | 0.02 | 17.25 | 0.64 | 0.15 | 0 | 0.02 | 0 |
| 12/16/98 | 3064 | 2.48 | 0 | 14.29 | 1.06 | 0.2 | 0.01 | 0.02 | 0 |
| 1/15/99 | 3268 | 2.52 | 1.4 | 13.05 | 0.19 | 0.09 | 0.01 | 0.27 | 0.17 |
| 1/25/99 | 3085 | 0.37 | 0.02 | 9.88 | 0.03 | 0.19 | 0.01 | 0.28 | 0.1 |
| 2/1/99 | 3184 | 0.36 | 0.02 | 10.34 | 0.04 | 0.08 | 0.01 | 0.64 | 0.64 |
| 2/24/99 | 3133 | 0.13 | 0.01 | 5.49 | 0 | 0.05 | 0 | 0 | 0 |
| 3/1/99 | 3266 | 0.27 | 0 | 10.22 | 0 | 0.12 | 0 | 0 | 0 |
| 3/22/99 | 3114 | 0.07 | 0.03 | 10.44 | 0.07 | 0.18 | 0.02 | 0.2 | 0.03 |
| 4/6/99 | 3154 | 0.23 | 0.01 | 10.08 | 0.01 | 0.06 | 0 | 0 | 0 |
| 4/18/99 | 3085 | 0.12 | 0.03 | 6.64 | 1.25 | 0.13 | 0.05 | 0.82 | 0 |
| 5/13/99 | 3187 | 0.15 | 0.01 | 6.79 | 0.06 | 0.04 | 0 | 0.71 | 0.13 |
| 5/19/99 | 3136 | 0.22 | 0.04 | 6.47 | 0.03 | 0.04 | 0.01 | 0.96 | 0.41 |
| 6/2/99 | 3268 | 0 | 0 | 5.2 | 0 | 0.05 | 0 | 0.61 | 0 |
| 6/16/99 | 3063 | 0.14 | 0.06 | 3.45 | 0 | 0.01 | 0.01 | 0.51 | 0.02 |
| 7/6/99 | 3268 | 0.03 | 0.03 | 5.4 | 0.06 | 0.02 | 0.02 | 0.37 | 0.04 |
| 7/19/99 | 3075 | 0 | 0 | 4.22 | 0.07 | 0.02 | 0.02 | 0.28 | 0.07 |
| 8/1/99 | 3146 | 0.07 | 0.01 | 9.42 | 0.18 | 0.05 | 0.01 | 0 | 0 |
| 8/16/99 | 3124 | 0.1 | 0.01 | 5.98 | 0.15 | 0.06 | 0 | 0 | 0 |
| 9/1/99 | 3198 | 0.03 | 0.01 | 3.64 | 0.07 | 0.01 | 0.01 | 0 | 0 |
| 9/18/99 | 3126 | 0.08 | 0.04 | 7.23 | 0.02 | 0.05 | 0.04 | 0 | 0 |
| 10/11/99 | 3163 | 0 | 0 | 3.82 | 0.04 | 0.04 | 0.01 | 1.08 | 0.18 |
| 10/25/99 | 3074 | 0 | 0 | 5.14 | 0.52 | 0.07 | 0 |  | ? |
| 11/8/99 | 3258 | 0 | 0 | 5.04 | 0.13 | 0.02 | 0.01 | 0.06 | 0 |
| 11/18/99 | 3033 | 0 | 0 | 5.44 | 1.61 | 0.05 | 0 | 1.55 | 0.72 |
| 12/7/99 | 3257 | 0.33 | 0.01 | 5.76 | 0.03 | 0.05 | 0 | 0.2 | 0.01 |
| 12/27/99 | 3145 | 1.26 | 0.07 | 8.99 | 0.35 | 0.19 | 0.03 | 0.22 | 0.01 |
| 1/10/00 | 3187 | 0.03 | 0.03 | 7.58 | 0.03 | 0.08 | 0.05 | 0.15 | 0.07 |
| 1/31/00 | 3041 | 1.1 | 0.01 | 13.2 | 2.33 | 0.29 | 0.01 | 0.56 | 0.17 |
| 2/7/00 | 3228 | 0.57 | 0.01 | 13.2 | 2.33 | 0.18 | 0.01 | 0.11 | 0.04 |
| 2/28/00 | 3042 | 1.56 | 0.25 | 7.14 | 0.21 | 0.01 | 0.01 | 0.1 | 0.08 |
| 3/9/00 | 3166 | 0 | 0 | 6.4 | 0.11 | 0.02 | 0.02 | 0.02 | 0.02 |
| 3/26/00 | 3095 | 0 | 0 | 5.27 | 0.11 | 0.05 | 0 | 0 | 0 |
| 4/13/00 | 3217 | 0.05 | 0 | 5.63 | 0.36 | 0.14 | 0.03 | 0.11 | 0.11 |
| 4/18/00 | 3075 | 0.04 | 0.04 | 5.58 | 0.12 | 0.18 | 0.04 | 0.11 | 0.03 |
| 5/11/00 | 3248 | 0.01 | 0.01 | 1.41 | 0 | 0.06 | 0 | 0.05 | 0.05 |
| 5/16/00 | 3062 | 0.01 | 0.01 | 4.72 | 0.05 | 0.08 | 0.02 | 0.05 | 0 |
| 6/13/00 | 3257 | 0.03 | 0.03 | 3.43 | 0 | 0.09 | 0.01 | 0.47 | 0.39 |
| 6/26/00 | 3156 | 0.18 | 0.04 | 24.81 | 0.28 | 0.13 | 0.01 | 0.19 | 0.06 |
| 7/5/00 | 3228 | 0.51 | 0.4 | 16.79 | 0.02 | 0.05 | 0.02 | 0.24 | 0.14 |
| 7/18/00 | 3085 | 0.11 | 0.04 | 3.73 | 1.02 | 0.03 | 0.02 | 0.11 | 0.05 |
| 8/4/00 | 3187 | 0.27 | 0.05 | 1.52 | 0.04 | 0.03 | 0.02 | 0.61 | 0.04 |
| 8/28/00 | 3125 | 0.07 | 0.02 | 14.88 | 0.14 | 0.02 | 0.01 | 0.03 | 0.01 |
| 9/6/00 | 3197 | 0.16 | 0.07 | 25.58 | 0.28 | 0.05 | 0.01 | 0.05 | 0.03 |
| 9/28/00 | 3094 | 0.06 | 0.02 | 4.97 | 0.38 | 0.06 | 0.01 | 0.09 | 0.02 |
| 10/13/00 | 3247 | 0.09 | 0.04 | 10.49 | 0.09 | 0.35 | 0.07 | 0.09 | 0.09 |

| Date | Grid | Nit avg | Nit s.e. | Si avg | Si s.e. | PO avg | PO s.e. | NH avg | NH s.e. |
|---|---|---|---|---|---|---|---|---|---|
| 10/16/00 | 3146 | 0.04 | 0.02 | 10.28 | 0.07 | 0.25 | 0.01 | 0.18 | 0.05 |
| 11/15/00 | 3187 | 1 | 0.03 | 6.44 | 0.09 | 0.22 | 0.07 | 0.41 | 0.03 |
| 11/22/00 | 3144 | 3.1 | 0.11 | 8.43 | 0.22 | 0.44 | 0 | 0.59 | 0.36 |
| 12/6/00 | 3257 | 1.18 | 0.01 | 6.21 | 0 | 0.38 | 0 | 0.64 | 0.03 |
| 12/28/00 | 3063 | 0.21 | 0 | 28.14 | 1.45 | 0.16 | 0.01 | 0.44 | 0.26 |
| 1/5/01 | 3095 | 0.72 | 0.02 | 31.25 | 2 | 0.17 | 0.02 | -0.06 | 0.06 |
| 1/16/01 | 3258 | 0.25 | 0.15 | 24.89 | 4.96 | 0.19 | 0.02 | -0.11 | 0.01 |
| 2/5/01 | 3165 | 0.17 | 0.07 | 3.3 | 0.54 | 0.19 | 0.06 | 0.06 | 0.04 |
| 2/20/01 | 3095 | 0.01 | 0.02 | 13.08 | 0.03 | 0.03 | 0.03 | -0.21 | 0.01 |
| 3/6/01 | 3208 | 0.3 | 0.03 | 34.44 | 0.35 | 0.22 | 0.03 | 0.49 | 0.16 |
| 3/30/01 | 3105 | 0.27 | 0.01 | 30.3 | 0.4 | 0.25 | 0.02 | 0.46 | 0.01 |
| 4/10/01 | 3268 | 0.08 | 0 | 21.37 | 0.16 | 0.2 | 0.01 | -0.21 | 0.03 |

## Appendix 4. Chlorophyll a and cell count data for Areas 17-21.

Chlorophyll is expressed in $\mu$g $L^{-1}$, cell counts in cell $L^{-1}$.

Table 1. Chlorophyll a and cell count data for Area 17, Sabine Pass.

Table 2. Chlorophyll a and cell count data for Area 18, Bolivar Roads Pass

Table 3. Chlorophyll a and cell count data for Area 19, Cavallo Pass.

Table 4. Chlorophyll a and cell count data for Area 20, Port Aransas Pass

Table 5. Chlorophyll a and cell count data for Area 21, Brazos Santiago Pass

On several occassions, samples of opportunity were collected by TPWD personel during the finfish surveys. These samples appear as multiple data for the same sampling date. The samples were analysed and are included in this appendix. Only regular monitoring data was included in the graphs.

Table 1. Chlorophyll a and cell count data for Area 17, Sabine Pass.

| Date | Area | Grid | Chl a avg | std error | *K. brevis* | *K. mikimotoi* |
|---|---|---|---|---|---|---|
| 11/3/98 | 17 | 212 | 1.84 | 0.20 | 0 | 0 |
| 11/16/98 | 17 | 3779 | 2.46 | 0.18 | 0 | 0 |
| 12/2/98 | 17 | 205 | 5.513 | 0.53 | 0 | 0 |
| 12/16/98 | 17 | 3778 | 1.29 | 0.10 | 0 | 50 |
| 1/11/99 | 17 | 201 | 5.95 | 0.4 | 0 | 75 |
| 1/19/99 | 17 | 3743 | 5.15 | 1.4 | 0 | 250 |
| 2/1/99 | 17 | 3778 | 1.075 | 0.2 | 0 | 250 |
| 2/18/99 | 17 | 3489 | 2.45 | 0.29 | 0 | 0 |
| 3/9/99 | 17 | 3491 | 12.54 | 5.35 | 0 | 100 |
| 3/22/99 | 17 | 240 | 8.5 | 1 | 0 | 0 |
| 4/6/99 | 17 | 174 | 6.13 | 2.2 | 0 | 50 |
| 4/27/99 | 17 | 212 | 3.05 | 0.4 | 0 | 0 |
| 5/7/99 | 17 | 3754 | 8.33 | 0 | 0 | 0 |
| 5/19/99 | 17 | 3790 | 6.38 | 1.8 | 0 | 0 |
| 6/7/99 | 17 | 243 | 5.29 | 1.65 | 0 | 0 |
| 6/16/99 | 17 | 3778 | 1.92 | 0.68 | 0 | 50 |
| 7/6/99 | 17 | 167 | 10.73 | 0.3 | 0 | 0 |
| 7/16/99 | 17 | 3790 | 4.24 | 0.35 | 0 | 0 |
| 8/2/99 | 17 | 138 | 1.83 | 0.7 | 0 | 0 |
| 8/17/99 | 17 | 3488 | 0.47 | 0.33 | 0 | 0 |
| 9/7/99 | 17 | 101 | 3.99 | 1.75 | 0 | 0 |
| 9/28/99 | 17 | 3764 | 0.73 | 0.03 | 0 | 125 |
| 10/11/99 | 17 | 3491 | 0.38 | 0.20 | 0 | 0 |
| 10/25/99 | 17 | 3767 | 1.02 | 0.81 | 50 | 0 |
| 11/1/99 | 17 | 105 | 2.20 | 0.05 | 0 | 0 |
| 11/17/99 | 17 | 3772 | 2.43 | 0.69 | 2500 | 7750 |
| 12/7/99 | 17 | 204 | 2.28 | 0 | 0 | 200 |
| 12/16/99 | 17 | 211 | 0.75 | 0.30 | 0 | 100 |
| 1/11/00 | 17 | 3492 | 1.52 | 0.42 | 0 | 50 |
| 1/17/00 | 17 | 3790 | 1.38 | 0.48 | 18600 | 600 |
| 2/9/00 | 17 | 131 | 0.78 | 0.37 | 0 | 0 |
| 2/16/00 | 17 | 211 | 1.33 | 0.38 | 0 | 50 |
| 3/9/00 | 17 | 3492 | 2.64 | 0.55 | 0 | 0 |
| 3/20/00 | 17 | 3753 | 3.45 | 1.2 | 0 | 0 |
| 4/5/00 | 17 | 175 | 2.26 | 0 | 0 | 0 |
| 4/18/00 | 17 | 3771 | 2.89 | 1.15 | 0 | 0 |
| 5/16/00 | 17 | 99 | 3.53 | 0.1 | 0 | 0 |
| 5/22/00 | 17 | 211 | 11.55 | 0 | 0 | 0 |
| 6/1/00 | 17 | 206 | 1.74 | 0.97 | 0 | 0 |
| 6/22/00 | 17 | 3491 | 1.77 | 0.92 | 0 | 0 |
| 7/6/00 | 17 | 210 | 2.22 | 0.85 | 0 | 0 |
| 7/17/00 | 17 | 212 | 2.06 | 1.19 | 75 | 0 |
| 8/3/00 | 17 | 172 | 1.13 | 1.31 | 0 | 0 |
| 8/16/00 | 17 | 3731 | 4.93 | 0 | 138000 | 0 |
| 8/16/00 | 17 | 3768 | | | missing | |
| 9/11/00 | 17 | 3766 | | | 252000 | 0 |
| 9/11/00 | 17 | 3783 | 3.8 | 2.2 | 116000 | 0 |

| Date | Area | Grid | Chl a avg | std error | *K. brevis* | *K. mikimotoi* |
|---|---|---|---|---|---|---|
| 9/18/00 | 17 | N/A | | | 474000 | 0 |
| 9/18/00 | 17 | 77 | 0.76 | 1.22 | 3000 | 0 |
| 9/18/00 | 17 | 175 | 3.91 | 1.45 | 250000 | 0 |
| 10/4/00 | 17 | 3491 | 2.06 | 0.45 | 0 | 0 |
| 10/17/00 | 17 | 3779 | 2.65 | 0 | 0 | 0 |
| 11/10/00 | 17 | 107 | 2.76 | 0.22 | 0 | 0 |
| 11/20/00 | 17 | 3786 | 1.58 | 0.23 | 10 | 0 |
| 12/6/00 | 17 | 211 | 2.94 | 2.26 | 270 | 0 |
| 12/29/00 | 17 | 3768 | 3.14 | 0.50 | 0 | 0 |
| 1/4/01 | 17 | 205 | 4.51 | 0.85 | 0 | 0 |
| 1/23/01 | 17 | 3488 | 13.38 | 2.1 | 0 | 0 |
| 2/5/01 | 17 | 134 | 3.68 | 1.3 | 0 | 0 |
| 2/19/01 | 17 | 3760 | 3.33 | 0.2 | 0 | 0 |
| 3/5/01 | 17 | 243 | | | 0 | 0 |
| 3/5/01 | 17 | 243 | 1.12 | 0.86 | | |
| 3/21/01 | 17 | 3740 | | | 0 | 40 |
| 3/21/01 | 17 | 3740 | 0.81 | 0.66 | | |
| 4/4/01 | 17 | 243 | | | 0 | 0 |
| 4/4/01 | 17 | 243 | 28.38 | 1.5 | | |

Table 2. Chlorophyll a and cell count data for Area 18, Bolivar Roads Pass.

| Date | Area | Grid | Chl a avg | std error | *K. brevis* | *K. mikimotoi* |
|---|---|---|---|---|---|---|
| 11/3/98 | 18 | 486 | 2.37 | 0.19 | 0 | 0 |
| 11/16/98 | 18 | 635 | 1.39 | 0.34 | 0 | 0 |
| 12/1/98 | 18 | 483 | 3.1 | 0.28 | 0 | 0 |
| 12/16/98 | 18 | 711 | 1.56 | 0.06 | 0 | 50 |
| 1/11/99 | 18 | 475 | 5.23 | 0 | 0 | 375 |
| 1/19/99 | 18 | 652 | 3.63 | 0 | 0 | 350 |
| 2/17/99 | 18 | 671 | 2.42 | 1.08 | 0 | 100 |
| 3/10/99 | 18 | 606 | 1.17 | 1.215 | 0 | 0 |
| 3/16/99 | 18 | 433 | 6.88 | 0 | 0 | 0 |
| 4/6/99 | 18 | 671 | 1.14 | 1 | 0 | 250 |
| 4/27/99 | 18 | 458 | 0.14 | 0.12 | 0 | 0 |
| 5/13/99 | 18 | 474 | 0.14 | 0.04 | 0 | 0 |
| 5/22/99 | 18 | 711 | | | missing | |
| 5/25/99 | 18 | 615 | 0.01 | 0.01 | 0 | 0 |
| 6/10/99 | 18 | 474 | 0.16 | 0.04 | 0 | 100 |
| 7/8/99 | 18 | 458 | 0.34 | 0.02 | 0 | 0 |
| 7/27/99 | 18 | 636 | 0.37 | 0.02 | 0 | 50 |
| 8/3/99 | 18 | 485 | 0.56 | 0 | 0 | 0 |
| 8/16/99 | 18 | 693 | 0.30 | 0 | 0 | 0 |
| 9/7/99 | 18 | 668 | 0.05 | 0.05 | 0 | 50 |
| 9/20/99 | 18 | 563 | 1.11 | 0.53 | 50 | 100 |
| 10/13/99 | 18 | 473 | 2.33 | 2.28 | 0 | 0 |
| 10/25/99 | 18 | 688 | 0.15 | 0.07 | 0 | 50 |
| 11/4/99 | 18 | 411 | 2.24 | 0.1 | 0 | 100 |
| 12/1/99 | 18 | 624 | 1.51 | 0 | 0 | 37500 |
| 12/14/99 | 18 | 474 | 1.53 | 0.08 | 0 | 750 |
| 12/16/99 | 18 | 692 | 1.40 | 0.57 | 0 | 6000 |
| 1/11/00 | 18 | 408 | 2.04 | 0 | 0 | 0 |
| 1/25/00 | 18 | 650 | 1.68 | 0.2 | 7250 | 1500 |
| 2/8/00 | 18 | 471 | 0.76 | 0.22 | 50 | 0 |
| 3/1/00 | 18 | 648 | 0.49 | 0.11 | 0 | 0 |
| 3/13/00 | 18 | 457 | 1.08 | 0.88 | 0 | 0 |
| 3/24/00 | 18 | 674 | 3.79 | 2.55 | 0 | 150 |
| 4/5/00 | 18 | 542 | | | 0 | 0 |
| 4/19/00 | 18 | 636 | 1.75 | 0 | 0 | 0 |
| 5/11/00 | 18 | 385 | 1.48 | 0 | 0 | 0 |
| 5/22/00 | 18 | 711 | 0.55 | 0 | 0 | 0 |
| 6/13/00 | 18 | 436 | 2.90 | 0 | 0 | 0 |
| 7/5/00 | 18 | 458 | 1.31 | 0 | 0 | 0 |
| 7/17/00 | 18 | 692 | 0.77 | 0 | 50 | 0 |
| 8/1/00 | 18 | 384 | | | 0 | 0 |
| 8/21/00 | 18 | 693 | | | missing | |
| 9/5/00 | 18 | 670 | 0.3988 | 0.25 | 0 | 0 |
| 9/27/00 | 18 | 468 | | | 5740 | 0 |
| 10/12/00 | 18 | 411 | 4.45 | 0 | 0 | 0 |
| 10/16/00 | 18 | 649 | 8.05 | 0.2 | missing | |
| 11/15/00 | 18 | 328 | 2.06 | 3.13 | 0 | 0 |

| Date | Area | Grid | Chl a avg | std error | *K. brevis* | *K. mikimotoi* |
|---|---|---|---|---|---|---|
| 11/28/00 | 18 | 692 | 0.78 | 0.65 | 0 | 0 |
| 12/7/00 | 18 | 487 | 0.30 | 0.05 | 440 | 0 |
| 12/29/00 | 18 | 674 | 2.33 | 1.2 | 0 | 0 |
| 1/15/01 | 18 | 692 | 10.09 | 1.81 | 0 | 0 |
| 1/22/01 | 18 | 533 | 11.18 | 0 | 40 | 0 |
| 2/5/01 | 18 | 329 | 2.80 | 1.8 | 0 | 0 |
| 2/20/01 | 18 | 691 | 2.26 | 0.68 | 0 | 0 |
| 3/5/01 | 18 | 692 | 0.47 | 0.83 | 0 | 0 |
| 3/20/01 | 18 | 435 | 0.77 | 1.62 | 0 | 240 |
| 4/2/01 | 18 | 521 | 13.75 | 0 | 0 | 140 |

Table 3. Chlorophyll a and cell count data for Area 19, Cavallo Pass.

| Date | Area | Grid | Chl a avg | std error | *K. brevis* | *K. mikimotoi* |
|---|---|---|---|---|---|---|
| 11/2/98 | 19 | 1586 | 1.28 | 0.13 | 0 | 162 |
| 11/16/98 | 19 | 1721 | 3.48 | 2.26 | 0 | 0 |
| 12/1/98 | 19 | 1587 | 1.67 | 0.11 | 0 | 50 |
| 12/16/98 | 19 | 1721 | 0.18 | 0 | 0 | 50 |
| 1/5/99 | 19 | 1554 | 2.06 | 0 | 0 | 0 |
| 1/18/99 | 19 | 1721 | 1.10 | 0.39 | 0 | 25 |
| 2/1/99 | 19 | 1512 | 0.27 | 0.07 | 0 | 50 |
| 2/18/99 | 19 | 1630 | 1.11 | 0 | 0 | 0 |
| 3/9/99 | 19 | 1585 | 0.45 | 0 | 0 | 0 |
| 3/16/99 | 19 | 1700 | 8.3 | 3.39 | 0 | 0 |
| 4/6/99 | 19 | 1599 | 3.69 | 3.18 | 0 | 150 |
| 4/19/99 | 19 | 1719 | 1.61 | 0.04 | 0 | 0 |
| 5/5/99 | 19 | 1553 | 0.53 | 0.00 | 0 | 0 |
| 5/19/99 | 19 | 1701 | 0.56 | 0.20 | 0 | 0 |
| 6/1/99 | 19 | 1570 | 1.09 | 0.11 | 0 | 0 |
| 6/16/99 | 19 | 1761 | 0.45 | 0.00 | 0 | 50 |
| 7/6/99 | 19 | 1535 | 0.23 | 0.07 | 0 | 100 |
| 7/20/99 | 19 | 1715 | 0.35 | 0.36 | 0 | 0 |
| 8/2/99 | 19 | 1681 | 0.21 | 0.02 | 0 | 0 |
| 8/16/99 | 19 | 1760 | 0.31 | 0.02 | 0 | 0 |
| 9/1/99 | 19 | 1582 | 0.43 | 0.15 | 0 | 0 |
| 9/20/99 | 19 | 1719 | 0.47 | 0.06 | 0 | 0 |
| 10/2/99 | 19 | 1554 | 0.82 | 0.10 | 0 | 0 |
| 10/21/99 | 19 | 1614 | 1.01 | 0.33 | 0 | 100 |
| 11/1/99 | 19 | 1572 | 0.22 | 0.00 | 0 | 0 |
| 11/16/99 | 19 | 1759 | 0.84 | 0.00 | 0 | 0 |
| 12/6/99 | 19 | 1596 | 1.26 | 0.44 | 0 | 400 |
| 12/16/99 | 19 | 1736 | 0.44 | 0.00 | 0 | 0 |
| 1/6/00 | 19 | 1582 | 0.10 | 0.00 | 0 | 0 |
| 1/17/00 | 19 | 1676 | 0.27 | 0.00 | 0 | 100 |
| 2/6/00 | 19 | 1508 | 1.92 | 0.00 | 0 | 0 |
| 2/16/00 | 19 | 1698 | 0.25 | 0.11 | 0 | 0 |
| 3/8/00 | 19 | 1572 | 1.00 | 0.00 | 0 | 0 |
| 3/27/00 | 19 | 1714 | 0.97 | 0.00 | 0 | 100 |
| 4/13/00 | 19 | 1466 | 0.15 | 0.13 | 0 | 0 |
| 4/16/00 | 19 | 1760 | 0.17 | 0.21 | 0 | 50 |
| 5/16/00 | 19 | 1615 | 0.73 | 0.00 | 0 | 50 |
| 5/21/00 | 19 | 1717 | 0.21 | 0.16 | 0 | 0 |
| 6/13/00 | 19 | 1534 | 1.56 | 0.00 | 0 | 0 |
| 6/27/00 | 19 | 1801 | 0.34 | 0.20 | 0 | 0 |
| 7/5/00 | 19 | 1583 | 0.19 | 0.12 | 0 | 0 |
| 7/18/00 | 19 | 1782 | 0.19 | 0.00 | 0 | 0 |
| 8/1/00 | 19 | 1552 | 0.34 | 0.16 | 130 | 0 |
| 8/16/00 | 19 | 1659 | 1.75 | 0.00 | 2000 | 0 |
| 9/9/00 | 19 | 1535 | 0.76 | 0.00 | 1120 | 0 |
| 9/19/00 | 19 | 1801 | | | 100 | 0 |
| 10/2/00 | 19 | 1554 | 0.36 | 0.00 | 169760 | 0 |

| Date | Area | Grid | Chl a avg | std error | *K. brevis* | *K. mikimotoi* |
|---|---|---|---|---|---|---|
| 10/18/00 | 19 | 1762 | 0.91 | 0.00 | 2000 | 0 |
| 11/10/00 | 19 | 1569 | 1.06 | 0.00 | 0 | 0 |
| 11/20/00 | 19 | 1693 | 1.22 | 4.78 | 0 | 0 |
| 12/5/00 | 19 | 1586 | 0.67 | 0.90 | 380 | 0 |
| 12/19/00 | 19 | 1720 | 0.50 | 0.85 | 200 | 0 |
| 1/4/01 | 19 | 1701 | 5.00 | 0.00 | 0 | 0 |
| 1/22/01 | 19 | 1587 | 3.13 | 0.00 | 100 | 0 |
| 2/12/01 | 19 | 1758 | 3.19 | 2.95 | 0 | 20 |
| 2/20/01 | 19 | 1585 | 2.04 | 0.68 | 0 | 20 |
| 3/5/01 | 19 | 1570 | 1.11 | 0.00 | 0 | 0 |
| 3/21/01 | 19 | 1646 | 0.60 | 1.42 | 0 | 0 |
| 4/10/01 | 19 | 1587 | 7.68 | 1.50 | 0 | 0 |

Table 4. Chlorophyll a and cell count data for Area 20, Port Aransas Pass

| Date | Area | Grid | Chl a avg | std error | *K. brevis* | *K. mikimotoi* |
|---|---|---|---|---|---|---|
| 11/15/98 | 20 | 2118 | 1.67 | 0.67 | 0 | 6 |
| 11/16/98 | 20 | 2238 | 1.71 | 0.07 | 0 | 0 |
| 12/1/98 | 20 | 2131 | 5.10 | 0.00 | missing | |
| 12/16/98 | 20 | 2226 | 0.81 | 0.41 | 0 | 175 |
| 1/5/99 | 20 | 2081 | 2.85 | 0.00 | 0 | 607 |
| 1/16/99 | 20 | 2190 | 1.94 | 1.26 | 0 | 225 |
| 2/14/99 | 20 | 2249 | 0.84 | 0.26 | 0 | 50 |
| 2/18/99 | 20 | 2130 | 0.40 | 0.20 | 0 | 50 |
| 3/24/99 | 20 | 2118 | 1.53 | 1.31 | 0 | 0 |
| 4/6/99 | 20 | 2154 | 5.29 | 3.18 | 0 | 0 |
| 4/27/99 | 20 | 2247 | 1.85 | 0.28 | 0 | 50 |
| 5/5/99 | 20 | 2248 | 0.93 | 0.00 | 0 | 0 |
| 5/19/99 | 20 | 2032 | 1.72 | 0.52 | 0 | 0 |
| 6/8/99 | 20 | 2202 | 0.38 | 0.00 | 0 | 0 |
| 6/16/99 | 20 | 2094 | | | 0 | 0 |
| 7/6/99 | 20 | 2117 | 0.34 | 0.25 | 0 | 0 |
| 7/28/99 | 20 | 2226 | 0.10 | 0.00 | 0 | 0 |
| 8/4/99 | 20 | 2070 | 0.13 | 0.06 | 0 | 0 |
| 8/17/99 | 20 | 2238 | 0.19 | 0.01 | 0 | 0 |
| 9/9/99 | 20 | 2031 | 0.31 | 0.03 | 0 | 0 |
| 9/20/99 | 20 | 2214 | 0.64 | 0.23 | 0 | 0 |
| 10/11/99 | 20 | 2127 | 1.37 | 0.37 | 0 | 0 |
| 10/22/99 | 20 | 2203 | 0.83 | 0.48 | | |
| 11/8/99 | 20 | 2070 | 0.30 | 0.07 | 0 | 0 |
| 11/23/99 | 20 | 2247 | 0.63 | 0.49 | 0 | 0 |
| 12/7/99 | 20 | 2068 | 0.85 | 0.39 | 0 | 0 |
| 12/17/99 | 20 | 2190 | 0.36 | 0.28 | 0 | 0 |
| 1/6/00 | 20 | 2032 | 0.51 | 0.09 | 0 | 0 |
| 1/17/00 | 20 | 2190 | | | missing | |
| 1/25/00 | 20 | 2144 | 0.49 | 0.08 | 0 | 0 |
| 2/8/00 | 20 | 2202 | 1.05 | 0.41 | 100 | 50 |
| 2/22/00 | 20 | 2058 | 0.25 | 0.12 | 0 | 0 |
| 3/1/00 | 20 | 2130 | 0.81 | 0.40 | 0 | 0 |
| 3/24/00 | 20 | 2118 | 0.74 | 0.74 | 0 | 0 |
| 4/13/00 | 20 | 2083 | 0.46 | 0.02 | 0 | 0 |
| 4/17/00 | 20 | 2188 | 0.25 | 0.04 | 0 | 0 |
| 5/10/00 | 20 | 2237 | 0.39 | 0.00 | 0 | 0 |
| 5/21/00 | 20 | 2046 | 0.27 | 0.21 | 0 | 0 |
| 6/6/00 | 20 | 2070 | 0.40 | 0.04 | 0 | 0 |
| 6/27/00 | 20 | 2131 | 0.08 | 0.09 | 0 | 0 |
| 7/5/00 | 20 | 2055 | 0.27 | 0.07 | 0 | 0 |
| 7/17/00 | 20 | 2155 | 0.15 | 0.12 | 50 | 0 |
| 8/2/00 | 20 | 2192 | 0.15 | 0.00 | 0 | 0 |
| 8/23/00 | 20 | 2102 | | | 40 | 0 |
| 9/5/00 | 20 | 2180 | 0.14 | 0.02 | 140 | 0 |
| 9/27/00 | 20 | 2045 | 1.29 | 0.17 | 4640 | 0 |
| 10/13/00 | 20 | 2033 | 2.36 | 0.65 | 20040 | 0 |

| Date | Area | Grid | Chl a avg | std error | *K. brevis* | *K. mikimotoi* |
|---|---|---|---|---|---|---|
| 10/19/00 | 20 | 2226 | 1.58 | 0.64 | 0 | 0 |
| 11/11/00 | 20 | 2179 | 2.14 | 0.36 | 0 | 0 |
| 11/21/00 | 20 | 2131 | 1.12 | 0.52 | | |
| 12/5/00 | 20 | 2105 | 0.94 | 0.50 | 20 | 0 |
| 12/16/00 | 20 | 2236 | 2.51 | 0.25 | 240 | 0 |
| 1/4/01 | 20 | 2033 | 2.99 | 0.15 | 0 | 0 |
| 1/12/01 | 20 | 2191 | 1.82 | 0.47 | 0 | 0 |
| 2/12/01 | 20 | 2177 | 2.43 | 0.25 | 0 | 10 |
| 2/19/01 | 20 | 2116 | 1.01 | 0.22 | 0 | 10 |
| 3/5/01 | 20 | 2156 | 0.55 | 0.48 | 0 | 120 |
| 3/21/01 | 20 | 2212 | 1.00 | 0.41 | 0 | 0 |
| 4/12/01 | 20 | 2080 | 3.16 | 0.15 | 0 | 0 |

Table 5. Chlorophyll a and cell count data for Area 21, Brazos Santiago Pass

| Date | Area | Grid | Chl a avg | std error | *K. brevis* | *K. mikimotoi* |
|---|---|---|---|---|---|---|
| 11/13/98 | 21 | 3198 | 0.89 | 0.63 | 0 | 20 |
| 11/17/98 | 21 | 3136 | 0.86 | 0.15 | 0 | 0 |
| 12/2/98 | 21 | 3145 | 0.55 | 0.12 | 0 | 0 |
| 12/16/98 | 21 | 3064 | 1.05 | 0.15 | 0 | 0 |
| 1/15/99 | 21 | 3268 | 1.47 | 0.92 | 0 | 200 |
| 1/25/99 | 21 | 3085 | 0.99 | 0.25 | 0 | 42 |
| 2/1/99 | 21 | 3184 | 0.85 | 0.49 | 0 | 0 |
| 2/24/99 | 21 | 3133 | 0.35 | 0.26 | 0 | 188 |
| 3/1/99 | 21 | 3266 | 0.13 | 0.03 | 0 | 83 |
| 3/22/99 | 21 | 3114 | 2.09 | 0.65 | 0 | 50 |
| 4/6/99 | 21 | 3154 | 0.26 | 0.02 | 0 | 0 |
| 4/18/99 | 21 | 3085 | 0.70 | 0.14 | 0 | 0 |
| 5/13/99 | 21 | 3187 | 0.32 | 0.01 | 0 | 200 |
| 5/19/99 | 21 | 3136 | 0.20 | 0.07 | missing | |
| 6/2/99 | 21 | 3268 | 0.27 | 0.02 | 0 | 100 |
| 6/16/99 | 21 | 3063 | 0.13 | 0.12 | 0 | 0 |
| 7/6/99 | 21 | 3268 | 0.21 | 0.00 | 0 | 0 |
| 7/19/99 | 21 | 3075 | 0.18 | 0.02 | 0 | 0 |
| 8/2/99 | 21 | 3146 | 0.17 | 0.03 | 0 | 0 |
| 8/16/99 | 21 | 3124 | | | 0 | 0 |
| 9/1/99 | 21 | 3198 | 0.10 | 0.14 | 0 | 0 |
| 9/18/99 | 21 | 3126 | 0.44 | 0.01 | 0 | 0 |
| 10/11/99 | 21 | 3163 | 0.47 | 0.29 | 0 | 0 |
| 10/25/99 | 21 | 3074 | 0.14 | 0.03 | 10000 | 0 |
| 11/8/99 | 21 | 3258 | 0.31 | 0.04 | 1500 | 0 |
| 11/18/99 | 21 | 3033 | 0.16 | 0.11 | 1500 | 0 |
| 12/7/99 | 21 | 3257 | 0.30 | 0.00 | 0 | 0 |
| 12/27/99 | 21 | 3145 | 0.54 | 0.00 | 0 | 0 |
| 1/10/00 | 21 | 3187 | 0.27 | 0.10 | 0 | 50 |
| 1/31/00 | 21 | 3041 | 0.58 | 0.00 | 150 | 0 |
| 2/7/00 | 21 | 3228 | 0.57 | 0.01 | 0 | 0 |
| 2/28/00 | 21 | 3042 | 0.11 | 0.20 | 0 | 0 |
| 3/9/00 | 21 | 3166 | 0.14 | 0.01 | 0 | 0 |
| 3/26/00 | 21 | 3095 | 1.00 | 0.20 | 0 | 0 |
| 4/13/00 | 21 | 3217 | 0.47 | 0.37 | 0 | 0 |
| 4/18/00 | 21 | 3075 | 0.39 | 0.39 | 0 | 0 |
| 5/11/00 | 21 | 3248 | 0.14 | 0.08 | 0 | 0 |
| 5/16/00 | 21 | 3062 | 0.53 | 0.38 | 150 | 50 |
| 6/3/00 | 21 | N/A | | | missing | |
| 6/13/00 | 21 | 3257 | 0.16 | 0.05 | 0 | 500 |
| 6/26/00 | 21 | 3156 | 0.24 | 0.08 | 0 | 0 |
| 7/5/00 | 21 | 3228 | 0.21 | 0.07 | 0 | 0 |
| 7/10/00 | 21 | 2981 | | | 1225 | 0 |
| 7/18/00 | 21 | 3085 | 0.11 | 0.06 | 0 | 0 |
| 8/4/00 | 21 | 3187 | 0.17 | 0.13 | 0 | 0 |
| 8/28/00 | 21 | 3125 | 0.13 | 0.02 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9/6/00 | 21 | 3197 | 0.27 | 0.00 | 0 | 0 |
| Date | Area | Grid | Chl a avg | std error | *K. brevis* | *K. mikimotoi* |
| 9/28/00 | 21 | 3094 | 0.95 | 0.00 | 0 | 0 |
| 10/13/00 | 21 | 3188 | | | missing | |
| 10/13/00 | 21 | 3247 | 7.79 | 1.35 | 352000 | 0 |
| 10/16/00 | 21 | 3146 | | | 109000 | 0 |
| 11/15/00 | 21 | 3187 | 1.32 | 0.04 | 0 | 0 |
| 11/22/00 | 21 | 3144 | 2.23 | 0.12 | 0 | 0 |
| 12/6/00 | 21 | 3257 | 0.72 | 0.18 | 0 | 0 |
| 12/28/00 | 21 | 3063 | 0.99 | 0.20 | 320 | 0 |
| 1/5/01 | 21 | 3095 | 0.91 | 0.35 | 0 | 0 |
| 1/16/01 | 21 | 3258 | 1.32 | 0.28 | 320 | 0 |
| 2/5/01 | 21 | 3156 | 0.25 | 0.11 | 0 | 0 |
| 2/20/01 | 21 | 3095 | 1.00 | 0.20 | 0 | 280 |
| 3/6/01 | 21 | 3208 | 0.46 | 0.07 | 0 | 300 |
| 3/30/01 | 21 | 3105 | 0.28 | 0.17 | 0 | 0 |
| 4/10/01 | 21 | 3268 | 0.19 | 0.01 | 0 | 20 |